THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 41. Thursday, August 1, 1929. No. 676.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (4 lines).

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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Event.

MAY-OCTOBER.

North-East Coast Exhibition at Newcastle-on-Tyne.

Low-Temperature Carbonisation.

The attention paid by the Press to the recent opening of a large-scale plant at Doncaster for the commercial production of smokeless fuel has served as a general reminder of the whole question of low-temperature carbonisation in Great Britain. So many inventors have concerned themselves with the question, and so many different processes have been developed and tried out, that it is not particularly difficult to understand the attitude of mind of the people who have declared not only that the commercial success of any such process is highly improbable, but also that the gas industry will remain the only successful carbonisation process. At the same time, it is obvious that capital would not be attracted to such a new industry unless money were being made in it, and it is also obvious to anyone who takes the trouble to study the subject that capital assuredly is being attracted to it at the present time, as witnessed by the opening already referred to. If once the process can be put upon a satisfactory commercial basis, it will certainly be to the advantage of the community that there should be a number of local plants to supply local fuel needs, in order that transport charges may be reduced to a minimum.

Incidentally, it is possible that the solution of those of our problems concerned with the oil supply may also lie in the development of the low-temperature carbonisation process, since oil is one of its by-products.

The interest of the community as a whole in this question of smokeless fuel is as yet hardly proportionate to its importance. Too many people are apt to think of the advantages to be derived from the use of smokeless fuel as being of an entirely æsthetic nature, and although they recognise that it would be pleasanter if our public buildings were white instead of the present dingy grey, they cannot raise a great deal of enthusiasm in this direction. They forget the enormous part of our national expenditure that is devoted to repairing the ravages made by the dirt from open fires—ravages on health as well as on cleanliness and beauty.

The founder, however, in addition to the interest that as a citizen he should take in the question of smokeless fuel, is concerned in two ways with this process of low-temperature carbonisation. In the first place, as user. There is the possibility of being able to use low-temperature coke for cupola melting and other foundry purposes; as a matter of fact already so much patent coke—that is, coke made in patent ovens as distinct from coke made in the old beehive oven—is in regular use that the average founder cannot say off-hand where his coke comes from. In the second place, as maker. It has been said with a good deal of justification that the progress of the low-temperature process depends upon the development of a satisfactory cast iron for the retorts, which are heated to 600 or 700 deg. C. as distinct from the much higher temperatures obtained in the refractory retorts of the gas industry. From these considerations it should be abundantly clear that the development of the low-temperature carbonisation industry is one to be watched by founders with close attention.

The New Light Castings Association.

If Dame Rumour is to be believed, the attempt to form an association to replace or extend the National Light Castings Association is not making much progress. The whole of the negotiations for its creation and development were conducted *in camera*, and we consider this to have had a detrimental effect on the progress achieved. Surely, in these enlightened days, the formation of an employers' federation is a matter of public interest and usually commendation. From our point of view, the basis upon which it is proposed to build is too narrow. Up to now, we are informed, only price regulation and "pooling" have been seriously considered. The older association undoubtedly did much good for the industry in many directions, but when trade became really bad many foundries resigned their membership—that is, just at the time when it is most needed. We consider that the existence of two associations in the light castings industry—one for industrial representation and a second for commercial co-operation—a weakness, as the true endeavour—industrial efficiency—is common ground for both. We are aware that the one is more predominantly Scottish than the other, though both associations have their headquarters north of the Tweed.

There is, moreover, too loose an association between the various national and local employers' federations, the engineering employers' organisations, the research and technical associations of the industry, and through this lack of contact the utility of each section is minimised and sometimes completely neutralised.

In wishing the new embryonic association every success in its endeavours, we invite them to reverse their policy of secrecy and to utilise our columns to make known their objectives; to state their difficulties and aspirations, and, as we are sure their endeavours are ethical, to enrol recruits.

XUM

Publications Received.

High-test Grey Iron. Part IV, Review of Literature from 1920 to 1928, by Dr. Edward E. Marbaker. Published by the Whiting Corporation of Harvey, Ill., U.S.A.

This eight-page pamphlet is one of the most useful of this series. It is rather a compliment to the European foundry Press that only one American reference is given, and even this is a contribution from Germany. So far as The Foundry Trade Journal is concerned, a practically complete abstracted bibliography is given. For those engaged upon the production of high-tensile iron they will find this pamphlet of the utmost use as a work of reference.

The Reactivity of Coke and **The Examination of a Number of Metallurgical Cokes,** by J. H. Jones, Ph.D., J. G. King, F.I.C., and F. S. Sinnatt, D.Sc. Published by H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 1s. net.

This pamphlet is one of a series of special reports on the results of work carried out at H.M. Fuel Research Station through its Northern and Midland Coke Research Committees. This Paper shows that a broad correlation exists between the behaviour of coke in the reactivity apparatus and its physical strength as determined by the Shatter test—a relationship of direct use to those in charge of cupolas. There is a growing interest by foundry owners in this aspect of fuel research, and as closer contact is sought by some sections of the industry it is desirable that all connected with this side of the trade should carefully study this and the other reports issued by the Fuel Research Board.

Aluminium in Marine Construction, by Edgar T. Painton, being a reprint of a Paper read before the Belfast Branch of the Association of Engineering and Shipbuilding Draughtsmen and published by the British Aluminium Company, Limited, Adelaide House, King William Street, London, E.C.4. Free on request.

Of the numerous indispensable brochures issued by this enterprising concern, none is more interesting to the foundry trade than the one under review. We were particularly intrigued with Table I, which we deem worthy of reproduction for criticism by ironfounders.

Table I.—*Economic Aspect of the Substitution of Aluminium for Cast Iron.*

	Aluminium castings.	Iron castings.
Initial cost ...	0.54 ton @ £140=£84.8	1.54 tons @ £20=£30.8
Scrap value ...	0.54 ton @ £75=£40.5	1.54 tons @ £2.5=£3.8
Difference = total depreciation	£24.3	£27.0
Annual Charges.		
Interest on capital ...	£84.8 @ 5%=£3.24	£30.8 @ 5%=£1.54
Annual depreciation ...	£24.3÷30=£0.81	£27.0÷30 =£0.90
Total annual charges ...	£4.05	£2.44

If calculations were as simple as is set out above, the problem would be extremely easy, but complications invariably creep in, such as alterations to existing patterns, lightening of correlated structures, corrosion resistance, freightage and many other factors. The enormous advance that aluminium castings have achieved in submarine furniture is noteworthy, and certainly calls for a correlated examination by marine engineers in general. The range of alloys, coming under the general classification, is extremely wide, and some can be relied upon to resist corrosion, except, of course, the direct action of sea water itself. The book contains 38 pages and is illustrated by an interesting series of photographs of actual castings used in marine construction.

Technical and Trade Education.

Dr. A. P. Lawrie, late Principal of Heriot Watt College, Edinburgh, speaking at a meeting of the Falkirk Rotary Club on July 25, chose "Technical and Trade Education" as his subject. At the outset the speaker explained that the foundation of all education was the capacity to do some useful kind of work and play a part in the production of the national wealth. The boy who showed himself proficient in the primary school passed on to the secondary school and eventually to the university, making use of the various bursaries and scholarships which exist. Everything was done to turn out that boy ultimately as a doctor or schoolmaster or whatever he wanted to be. But in the case of the boy, perhaps from the same household, who was going to remain a member of the working class, they were not taking very much trouble with him. On reaching fourteen years of age he goes out to try and take up a job, falling a victim eventually to an employer who keeps him until he is sixteen or seventeen and then turns him out, equipped with no trade or education for his future life.

There were two kinds of unemployed—those who were unemployed on account of the depression in trade, such as miners—and those classed as unemployable, who were dragging on the wheels of trade and progress for the whole of their lives—casual people. In the speaker's opinion, the present scheme, endorsed by the Government, to raise the school age to 15 would benefit the country by stimulating more interest in what happened to these boys after they left school, because it was then that the wastage began. They were no longer training the new workman as they had done in the past, and in order to remedy this, evening classes of all kinds were being started. The evening classes were, however, a poor makeshift, and they must face the fact that in order to train their future skilled workers they would require to give them a certain amount of time during the day to get the proper training in their trade. There was a certain element of truth in the popular idea that with the change of industry no training was required on account of the increase of machinery, but what was more true was the fact that in modern industry they wanted much more highly-trained men among the working classes than they had in the past. He had heard of a proposal to introduce a new process or machine turned down because the workmen had not sufficient intelligence to grasp the working of the new process or machine. There was not such a demand for trained craftsmen as for men who could adapt themselves quickly to the new processes and machines which were coming forward every day. They wanted more of a college and less of a workshop education in the future. More intelligence and broad scientific training was required for the development of modern industry, and that could only be met by giving young people industrial education.

In France, Germany and America there was a tendency to train young people for their future occupation entirely in a technical school. From the point of view of a practical business nation we were not devoting enough time to the question of what is to become of the boy when he leaves school. It was a very important practical question. We were training the future specialists in the schools and universities to hold their own anywhere in the world, but they had also to consider the workman and his training. As machinery developed there was no reason why an intelligent man should not shift about from one job to another. He regarded trade unionism in this country as the most conservative, the most tory and the most old-fashioned institution in the whole land. They suffered from a terribly old-fashioned toryism. They should be much more flexible, industry was changing in the direction of not wanting less training but more training.

Random Shots.

At this time of year it is customary to take part in the perennial controversy that rages over The Holiday Abroad. We hear of its advantages—economy, novelty, *joie de vivre*, and so on. We hear of its disadvantages—customs, passports, no soap in the hotel bedrooms, and all the rest of it. We also hear that it is so good for the children's language studies to take them abroad now and then, and, alternatively, that no one need be afraid to cross the Channel because he does not talk French, German, Italian, Hindustani, or whatever they *do* mistakenly but commonly talk in the land of his choice. Personally, I am inclined to agree with Albert. . . . But of that, more later. . . .

* * *

However, there is one useful contribution I can make to the discussion, and that is on this question of languages. The important thing is, not so much to learn the language of the country you propose to visit, but to learn the *English* of the country you propose to visit. They all talk English—or they all think they can—but all too often it isn't the English with which you and I are familiar. Some day, when I have retired from business, I shall make a fortune and perform a public benefaction by compiling a dictionary of English "as she is spoke" elsewhere, and chiefly in France, where they pride themselves particularly in the matter.

* * *

And, in the meantime, let me give you just a few examples. In two of the most important spheres of life—sport and the bar (the cocktail bar, not the legal one)—the Frenchman talks very little but English, although it is sometimes hard to recognise it as such. Certain words—"le sport" and "le coktail"—suitably pronounced are now considered to have become indigenous, however peculiar they may look on paper. "Le tennis," "le golf," "le football," these are well-known examples. We also find "bar," "barman," "ginfizz"—a little doubtful, this last—and sundry others. These, of course, are fairly straightforward, provided you can understand the pronunciation. Where the trouble begins is a little further on. There is, for instance, a nasty trick of using the present participle as a noun, and not always as the right noun. Thus, "smoking" means, not the act of smoking a pipe or a cigarette, but the garment worn on informal-evening occasions by gentlemen, so that we get something of this sort:—English, dinner-jacket; French, smoking; American, tuxedo. Similarly, "dancing" does not mean the performance of fox-trots or tangoes, but the room, hall, cabaret or apartment wherein they are performed, or, sometimes, the social event for which they provide the excuse; *i.e.*, dancing = dance-hall or ball. All very confusing, isn't it?

* * *

Albert Tells the World. . . .

I. *What he thinks about Holidays.*

"Holidays? No, it's no problem for me, Blackpool's mine, this year, next year, an' every year. O' course I know some folks goes abroad—day trip to Boulogne, 7*s.* 6½*d.*, leave 'ome at one in the mornin' an' get back at midnight, an' cheap at the price, I daresay. . . .

"Too far? I suppose it is. Cousin o' my missus—lives in London, pore feller—'e goes to Margate. . . .

"No, I've never been there, but from what I've 'eard tell I should think as the feller what invented Margate must 'a' had a good look at Blackpool first an' then gone an' forgot it on the way 'ome. . . .

"Still, p'r'haps it's as well. Apt to get a bit full at times, Blackpool is, so maybe even Boulogne 'as its uses . . ."

Marksman.

Annual Meeting of the German Foundry Technical Association.

The German Foundry Technical Association, which this year completes its 20th anniversary, held its annual meeting in Berlin from May 24 to 26, Dr. Humperdinck, of Wetzlar, being in the chair. The meeting was attended by more than 500 foundrymen from Germany and foreign countries, including numerous representatives of the Hungarian industry.

The general meeting opened with a meeting of the Electric Furnace Section on Friday, May 24, in the lecture hall of the Geological Survey in Berlin.

Four Papers, abstracts of which appear below, were on the agenda.

Quality Questions in Electric Steelworks.

By K. von Kerpely.

Last year the *Drahtindustrie A.-G.* (Wire Manufacturing Company, Limited) installed, in their works at Campia Turzii (Rumania), an electric steel plant equipped on modern lines, in which a 1-ton Héroult-Lindenberg electric furnace is at present working in connection with the production of high quality steel, particularly for the manufacture of wire ropes. This furnace is supplied by the Company's own three-phase alternator of 550 k.v.a. capacity at 380 volts pressure, directly coupled to a natural-gas engine installed in the power house in the vicinity. The available reports show that the gas engine has been able satisfactorily to cope with the fluctuating loads of electric furnace operation.

The steelworks building occupies an area of approximately 46 × 50 ft., and a scrap store and test and research laboratory adjoins it. The furnace room has a 46 ft. span and a height of 33 ft. to the lower edge of the main joists. A 5-ton triple-motor travelling crane runs the length of the building and assists melting and casting operations. The furnace is readily accessible from every side. The transformer and switch-room are in the immediate vicinity of the furnace, so that conductor losses are reduced to the minimum. The furnace equipment consists of a Brown-Boveri 500 k.v.a. three-phase oil transformer, with automatic hydraulic electrode-regulating gear, together with the necessary switchgear. The furnace is operated with a secondary voltage of 145/100/80 volts. The furnace can be satisfactorily run off 145 volts when the alternator output is 550 k.v.a., the best pressure being 110 volts, which is the pressure mainly used for finishing the charge. The current required for melting down the charge is approximately 550-620 kw., and the total current consumption for wire-rope steel 1,000-1,100 units per ton.

A remarkable feature of this furnace is the lining. The entire hearth is lined out with standard magnesite bricks to the arch. The hearth consists of three flat courses and one brick-on-edge course of dry bricks. This type of lining has given satisfactory results: the hearth has a much longer life than where the lining is rammed, and 20 per cent. has been saved on repair mixture costs. The advantage of the bricked hearth was specially marked when melting cast iron and steel alternately. The roof is bricked in the ordinary way with "Dinas" bricks, but a small gap some 3 in. × 3 in. is left open in the second row of bricks to the right of the tap-hole. This sets up a slight draught, which passes along the arch, and prevents the roof dripping. The life of the roof under these conditions is 80 to 90 charges, associated with a refining period of 2 hrs. The consumption of Acheson graphite electrodes is about 15½ lbs. per 1,000 kw.

The writer also discussed the effect of the melting operations—and particularly of the carbide slag and the ferro-carbon-titanium, added to the charge at the rate of 1 per cent. of the weight of the steel bath—on the quality of the ingots produced. Siliconised steel treated with Fe-C-Ti exhibited a much smaller number of inclusions, so that the use of Fe-C-Ti can be recommended for the manufacture of high-quality wire rope steel.

The essential conditions to success are hot melts, ingot moulds that are as small as possible, and casting at low temperature. The author also dealt in detail with the difficulties that were encountered initially in casting the steel, and concludes with some remarks regarding the organisation of operations in an electric steel works.

The Coreless Induction Furnace, with Particular Reference to Special Types.

By Dipl.-Ing. M. H. Kraemer, Berlin.

The first successful attempts to melt metals inductively without an iron circuit and using high frequencies were carried out in Germany in 1912-13 with the Poulsen arc transmitter. During the war, Northrup in America, and shortly after the war Ribaud in France, evolved practical melting plants operating with high frequency, the oscillations being generated by mercury or rotary spark-gaps. The need for larger furnaces led to the erection in America and Germany simultaneously of melting plants with oscillations set up by the recognised types of machine transmitters.

For medium-sized and very large plants, the present trend of developments is in the direction of medium and lower frequencies, such as can be supplied directly by normally running machines. Independently of this, endeavours are being made to explore the region of higher and the highest frequencies for metallurgy. The methods which may lead to this end are in the multiplication of frequencies by static transformers, the spark-gap type of furnace and the furnace operated with an electron tube.

A typical plant is the melting set which has been built in the Metallurgical Institute of the Berlin Technical College. This plant is operated on a special circuit arranged to give a frequency range of 20,000 to 200,000 hertz (cycles per second). The oscillations are supplied by battery of condensers connected in parallel, excited by alternating current of 50 cycles per second (hertz), the condensers being controlled by a rotary spark gap. The characteristic feature of melting operations carried out in the coreless induction furnace lies in the "pinch effect," which opens up new metallurgical possibilities and advantages, although it has certain drawbacks.

The cheapness of this melting process seems to be assured, as the question of the furnace lining has been favourably solved by the sintering process. A definite opinion cannot be pronounced until the 1-ton furnaces now being built have been operated for some time. The coreless induction furnace will certainly not displace any other metallurgical furnace, with the exception of the "iron circuit" induction furnace which, however, has already lost some of its importance.

The coreless type of induction furnace has opened up a new phase of possibilities from the standpoint of metallurgy, and it will probably be used as the final phase for refining purposes in conjunction with recognised processes. Unless the eddy phenomenon can be suitably damped or eliminated by throttling the energy, this method of melting must be regarded with a certain amount of reserve. The indicated field for this method of operation is, however, the large works type of vacuum furnace, which offers great possibilities both for non-ferrous metals and steels.

Operating Data of American Electric Furnaces.

By Dr. K. F. Krau, Magdeburg.

The electric furnaces included in the investigation varied from 14 cwts. to 3½ tons capacity, and all were arranged to operate on the acid process for the production of steel castings. In selecting the size of the furnace account was taken of the fact that only when fully utilised can an electric furnace successfully compete with a fuel-fired electric furnace. The small type of furnace therefore predominated. The question of the furnace lining was decided, in the case of the acid furnace, by the raw material basis, as most of the plants are able to use a uniform charge of fresh scrap punchings and other similar types of scrap.

Due to the predominance of the acid method, the furnace roofs last for as many as 250 melts, which is generally not possible with the basic method. The roofs exhibiting the longest service life were composed of suitably shaped bricks set without cement, the expansion joints being of soft wood. Acheson graphite electrodes were used exclusively in the furnaces investigated, and these proved very successful. The furnace pressures between the electrodes were usually round about 130 volts, although voltages down to 84 volts were met with for refining purposes.

The Production of Synthetic Grey Cast Iron in the Electric Furnace.

By Dr.-Ing. Nathusius, Mannheim.

After outlining the numerous suggestions that have previously been made with regard to the "treatment" of grey cast iron for improving its quality, the author describes the manufacture of synthetic pig-iron and grey iron in the electric furnace. He also explains the details of a process, elaborated by B.B.C. (Brown-Boveri Company) and Sulzer Brothers, for manufacturing high-quality electric grey cast iron from dead mild steel scrap. He discusses in detail the results hitherto obtained with this process, and compares them with the results of the processes mentioned at the beginning. He also discusses the results of experiments on the growth of electric synthetic grey cast iron.

The Paper concludes with a brief review of the scope of electric synthetic grey cast iron.

Second Day.

The morning of the following day was spent in inspecting the works of Messrs. Julius Pintsch, of Fürstenwalde, and Messrs. Carl Schoening, of Berlin-Reinickendorf-Ost, and a general visit to the Gas and Water Exhibition.

A preliminary meeting took place in the afternoon of May 25, and abstracts are printed below of the three Papers which were read.

Development of a New Deoxidising and Melting Process for Metals, especially for Copper Alloys.

By Dipl.-Ingenieur Reitmeister, Kirchmöser.

The author first deals briefly with the relations which exist between iron and copper alloys, and points out that certain laws of metallurgy are of more general significance than is usually supposed. This refers to the deoxidation of metal baths by means of charcoal, and the effect of the oxide content of the metal on zonal segregations in the castings. As regards the behaviour of the gunmetal alloys, the author's observations were found to afford complete confirmation with what a number of experiments had previously found with iron alloys. He shows that the tendency of the raw material to segregate in the case of gunmetal is not obviated by the simple process of remelting, and can be found to a proportionate extent in the finished castings.

The author then recounted how, inspired by a paper by Schenk on "The Application of Theoretical Chemistry" to a few of the processes which are of importance in the production of steel, he attempted the deoxidation of gunmetal

baths with charcoal. The results at first were very good, but afterwards became just the opposite. Further experiments showed that the segregations in the case of gunmetal are caused (1) by the oxide content of the raw material, and (2) that they are considerably intensified by over-carburisation of the raw material. With a view to reducing segregations, the oxides were removed from the molten bath by a new method developed by the author, and employing charcoal, this method at the same time prevents over-carburisation. The process presupposes that the baths are oxidic. If they are not, the quality of the metal, in the case of gunmetal, is easily impaired, probably due to the absorption of carbon monoxide gas by the over-reduced molten bath.

Assisted by the results of experiments by Goerens on the gas content of Siemens steel before and after deoxidation, the author attempts to explain why deoxidation in steel baths is not completely effected by ferro-manganese. Similar conditions obtain in the case of over-reduced gunmetal melts. In order to obtain gunmetal exhibiting the best properties, any carbon present must be reduced by intense oxidation. This is followed by the effectual deoxidation of the molten bath by the process mentioned. The Paper concludes with some results obtained from the process as applied for some considerable time on a practical test scale.

The Human Strain Element in Foundry Operations.

By Oberingenieur G. Stern, Frankfort.

Certain drastic measures are necessary for improving the state of industry in Germany, which is in a bad way. These measures are: a reasonable policy and a tariff policy properly adapted to industrial and economic requirements. In addition, however, new industrial measures are called for, which may be briefly summarised as follows:—

(1) Reduction of prices for industrial products, and, hence, the creation of a suitable inland market and an export market for the home products due to the prices being adapted to the world's markets; (2) if possible, the quality of the products should be raised at the same time. and (3) organisation of a suitable and powerful sales machinery and propaganda service.

Any successful scheme of rationalisation must enable industry to make the necessary profit from a proper turnover sold at prices which can compete in the markets of the world. The usual practice hitherto has been to measure work done merely in terms of time expended, as measured with a stop-watch; whereas the true aim should be to get better outputs (and more profits) for less expenditure of energy. As with every technical machine, so with the human machine, we have not simply to inquire what power the machine delivers in a given unit of time, but how many kilowatts, horse power, calories, or other units must be expended to perform the work required. Rationalisation estimated on the basis of the stop-watch may fail because the man engaged on production may under certain circumstances be unable to expend the necessary power or the necessary calories per unit of time or per job for the work which is demanded of him. The further we go with rationalisation, the more we realise that at least as much and even more interest must be taken in the investigation of the power consumed than is devoted to the time study.

Experiments in this direction have been carried out at the author's foundry by Dr. Simonsohn, an industrial physiologist, at the suggestion of Dr. Ascher, the Frankfort Medical Officer of Health, and these have yielded very interesting results both from the point of view of works organisation and industrial physiology. In order to ascertain the consumption of calories in the several working processes, the amount of oxygen consumed and the volume of carbon dioxide gas expelled in doing work were measured. Comparing the work done in compressing sand with the hand rammer, with the hand-lever press and with the hydraulic press, it is possible to see how the work performed can be improved by altering the machine. The calories per job drop from 11,479 to 9,569 and 5,820; the calories per minute increase, with increased effort or output, from 4,049 to 5,110 and 5,640, with a corresponding increase in output from 0.353 operations (or castings) per minute, to 0.518 and 0.978. In addition to saving the time laid down by the rationalisation technically necessary, endeavours must be made to restrict the power consumed per minute, *i.e.*, to save calories without reducing the intensity of production.

The analysis of the several working processes for ascertaining the calories consumed on the several operations constituting a job shows the necessity for simplifying or eliminating the elements of labour which involve a particularly large consumption of energy. These are mostly subsidiary jobs such, for instance, as transport of the full and empty boxes, smoothing sand surfaces, shovelling sand and wedging up boxes. We see then that these experiments afford quite a number of constructive suggestions for manufacturers of moulding machines such, for instance, as simplifying the operation of the swinging motion or the compressing lever, etc. There is also an absence of suitable smoothing arrangements for the rammed boxes, and this raises an entirely fresh technical problem. The industrial physiologist can therefore show the machine designer new methods of designing the details of the machine; because the efficiency of the machine and the calories consumed by its operator depend upon the way the moving parts are supported even in insignificant movements such as are usual in moulding machines.

In all manufacturing processes where, as in the foundry, human energy plays an essential part in the process of production, the industrial physiologist is a valuable auxiliary in the rationalisation of industry. He is qualified to reconcile the apparent contradictions involved in the terms "Saving in money expenditure with increase in production" and "Power saved, with increase of yield or profit." Since man was created, his every thought and action has been directed to one point, and industrial and technical development has had no other aim than to free man more and more from the burden of work and to grant him a still greater share of the enjoyment of the product produced, for that, after all, is the real meaning of cultural development.

The Development of Methods of Mixing and Melting Cast Iron during the Past 50 Years.

By Oberingenieur Chr. Gilles, Berlin.

The tremendous developments in the ferrous and non-ferrous metals industry during the last quarter of the past century were, generally speaking, accompanied by progress in manufacture, but not in the iron foundries, where innovations were only made with difficulty. Even in that period there were cupolas of thoroughly sound design, *e.g.*, the Krigar furnace, but these were a long time in replacing the old boilers, being introduced first of all into a few works, mostly foundries run in conjunction with large engineering works. When selecting the pig-iron for the mixture, it was usual to judge the strength from the resistance of the pigs to fracturing; and if the surfaces of the pigs were sunken, this was regarded as a tendency to considerable shrinkage. If the fractured surface of the pig was fine-grained, it was expected that the grain of the cast iron would be correspondingly fine. English and Scotch pig-irons were generally preferred to German in the foundries, and the German blast-furnace industry was hard put to it to remove a prejudice for which there were no grounds. The method of casting adopted at that time probably differed very little from the present method.

Since we are hearing so much to-day of fresh suggestions of a scientific nature, it is interesting to point out that, even in the 'seventies of last century, scientists had penetrated deeply into the secrets of the founder's art. Durre, for instance, emphasised the importance of chemical analysis, without, however, regarding them as a panacea. He gave special attention to the processes of crystallisation. Ledebur did work which largely helped to explain the metallurgical processes that take place when iron is melted, and to develop founding in general. Reference should also be made to the fundamental researches of Wüst, which led to the rule of adopting suitable percentages of silicon and manganese for the various sections of castings and for dry and green sand moulding.

In the endeavour to make German foundries independent of English and Scotch foundry pig-irons, Jüngst carried out melting tests with ferro-silicon in the cupola in 1887, and suggested that work be carried out on these lines to guide the foundryman. He had slides of the test pieces made in the 'eighties, so that metallography was in use even at that period. Jüngst increased the percentage of wrought-iron scrap to 70 per cent., and obtained high-strength castings. At the beginning of the present century higher strength figures were attained with the introduction of briquettes made of steel and cast-iron turnings as an addition to the charge.

Almost at the same period that these briquettes were being widely adopted, came the low-carbon pig-iron of the Concordiahütte and the Friedrich Wilhelmshütte. It was a happy idea on the part of Hennings to reduce the carbon content of pig-iron to 2.6 to 2.8 per cent. by mixing liquid steel and pig-iron. This iron has proved satisfactory right down to the present, and even now is being used with advantage where electric and special furnaces and processes are not used in conjunction with the standard cupola.

The greatest difficulty in getting high strength and dense castings is not exactly in the production of the iron itself, but depends on manual operations, which are many and varied, if first-class castings of complicated shapes are required. Of the more recent attempts made to improve the quality of cast iron, the work of Diefenthäler should be specially mentioned, as he was one of the first foundry engineers to utilise the knowledge afforded by metallography. The use of fairly large quantities of steel and wrought-iron scrap in the cupola is a matter that has given rise for extensive discussions in the last few years. This question was tackled during the war by Corsalli, whilst Emmel was very successful with the use of fairly large quantities of steel and wrought-iron scrap in the cupola. He showed convincingly that a pearlitic structure can be obtained in various ways.

The important part played in pig and cast iron by graphite, both in kind and quantity, has already been indicated by Ledebur, Wüst, Leyde and others, and among more recent workers in this field are the Japanese, Honda and Murakami. It is also claimed that the graphite can be refined by joggling or shaking the bath. The electric furnace, too, may be mentioned as a means of improving grey cast iron. All sorts of methods have been adopted to get a high-quality cast iron. There has been no appreciable development in connection with melting and mixing methods, *i.e.*, on the purely metallurgical side of foundry work, and what development there has been has not kept pace with the design and mechanical engineering side of foundry operations. Now that we are certain that there is a cast iron exhibiting special properties, we must find means of definitely obtaining it.

At the end of his paper Gilles has something to say in connection with the granting of patents which constitute not so much a discovery as a scientific recognition or a metallographic explanation of a metallurgical process. He regards as particularly objectionable the patenting of

(*Continued on page* 86.)

Manganese in Cast Iron.*

By A. L. Norbury, D.Sc.

Introduction.

Considerable differences of opinion exist as to the influence of manganese on the chilling properties of cast iron. Some hold the view that manganese decreases the tendency to chill, others that it increases the tendency to chill. For instance, many manufacturers of chilled rolls find that manganese additions decrease the depth of chill, while many manufacturers of grey-iron castings find that manganese increases the tendency to chill. Evidence is available in support of each view. Some published results, for instance, indicate (1) that as the manganese content of a grey iron (containing only traces, *e.g.*, 0.01 per cent. sulphur) is increased from 0.0 per cent. to about 0.3 per cent. manganese it exerts a graphitising action on the cementite. Other results indicate (2) that additions of 1 per cent. and upwards of manganese exert a chilling action.

Experiments have been carried out to check the above apparently conflicting results and have confirmed them. The explanation appears, however, to be that the graphitising action of manganese only occurs in low-manganese irons and is an indirect one due to its capacity for combining with sulphur. The presence of only traces (*e.g.*, 0.01 per cent.) of free sulphur is sufficient to prevent the graphitisation of considerable quantities of cementite and an excess of manganese (above that required to form MnS) is required to neutralise the stabilising action of such sulphur on the cementite. Apart from this indirect action, manganese always exerts a stabilising action on cementite. Evidence bearing firstly on the graphitising action, and secondly on the chilling action of manganese is summarised below.

Graphitising Action of Manganese.

Hague and Turner[1] were apparently the first to draw attention to the graphitising action of small quantities of manganese. They found that increasing the manganese content of a grey iron (T.C. 2.6 per cent., Si 3.0 per cent., P trace, S trace) from 0.03 to 0.5 per cent. caused the following marked differences: (a) the combined-carbon content fell from 1.03 to 0.22 per cent.; (b) an expansion occurred at 687 deg. C. on cooling (without manganese no expansion was obtained at these low temperatures), and (c) the pearlite matrix was largely decomposed into ferrite and graphite.

Coe[2] confirmed the above result, and in a grey iron containing total carbon 2.8 per cent., Si 1.8 per cent., S trace, P trace, found that with manganese 0.03 per cent. there were numerous small crystals of cementite, while with manganese 0.18 per cent. and upwards, the crystals of cementite were absent and a considerable portion of the pearlite had been decomposed into ferrite and graphite.

Data from papers by Coe[3] and Wüst and Meissner[4] showing the effect of small additions of manganese in decreasing the combined-carbon contents of grey irons have been plotted in Fig. 1. It will be seen that increasing the manganese content from 0.03 per cent. to about 0.3 per cent. in these grey irons causes a fall in combined carbon in every case—which is in accordance with the findings of Hague and Turner, and Coe. Further additions of manganese cause a slight increase in the combined carbon content.

These results have been confirmed by casting similar series of grey-iron bars containing increasing quantities of manganese between 0.0 and 0.5 per cent. In each case as the manganese was increased from 0.0 per cent. to about 0.3 per cent., the combined carbon fell from about 1.3 to below 0.9 per cent. Some analyses showing this are given in Table I.

The graphitising action of manganese, if increased from 0.0 to 0.3 per cent. or over, on the secondary cementite in grey iron is confirmed

DR. A. L. NORBURY.

in a somewhat different manner by means of the data plotted in Figs. 2A and 2B. These figures show the combined-carbon contents of

TABLE I.—*Effect of small percentages of manganese on combined contents of 1.2 dia. sand-cast grey-iron bars.*

Series A.

No. of test bar	1.	2.	3.
C. C.	1.29	0.91	0.54
Mn	0.02	0.10	0.33

T.C., 3.0; Si, 1.9; S, 0.03; P, 0.03 per cent.

Series B.

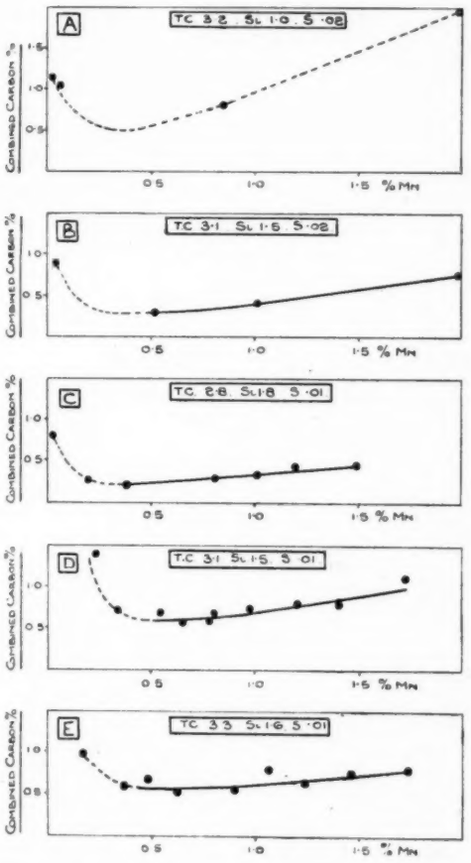
No. of test bar ..	4.	5.	6.	7.	8.
C. C.	1.29	1.10	0.99	0.90	0.84
Mn	0.06	0.11	0.20	0.24	0.43

T.C., 2.77; Si, 1.53; S, 0.03; P, 0.03 per cent.

1.2 in. diameter sand-cast bars of various carbon and silicon contents. The vertical position of each dot in these figures indicates the total-carbon content, while the horizontal position indicates the silicon content, and against each dot is written the combined-carbon content. The results in Fig. 2A have been taken from data published by Maurer[5] and *contain* 0.68 *to* 1.23 *per cent. manganese* and 0.04 to 0.13 per cent. S. Those in Fig. 2B *contain manganese below* 0.2 *per cent.* and 0.01 to 0.03 per cent. S and have been taken from a Paper by Wüst and Kettenbach.[6] Compositions to the right of the curved chill lines would be grey. The combined-carbon contents of the grey irons in Fig. 2A (Mn 0.68 to 1.23 per cent.) average about 0.9 per cent. combined carbon; those in Fig. 2B (Mn below 0.2 per cent.) are, however, obviously exceptionally high, averaging about 1.3 per cent. combined carbon. The high combined-carbon contents in Fig 2B are, as before, the result of low-manganese contents (below 0.2 per cent. in this case).

Effects of Phosphorus, Nickel and Aluminium.

Manganese appears to be the only element commonly alloyed with cast iron which can graphitise the secondary cementite in the above manner. That neither phosphorus, nickel nor aluminium has this action is evident from the



FIGS. 1A, 1B, 1C, 1D, 1E.—EFFECT OF MANGANESE ON THE COMBINED-CARBON CONTENTS OF GREY IRON BARS. FIGS. 1A, 1B, 1C HAVE BEEN CONSTRUCTED FROM DATA PUBLISHED BY COE FOR 2 IN. × 1 IN. BARS; FIGS. 1D AND 1E FROM DATA PUBLISHED BY WÜST FOR 1.2 IN. BARS.

following data, viz., Wüst and Stotz's[7] data giving the combined-carbon content of 1.2 in. dia. sand-cast grey-iron bars containing manganese below 0.2 per cent. and sulphur below 0.03 per cent. and various amounts of carbon, silicon and phosphorus show high combined-carbon contents similar to those in Fig 2B (viz., 1.3 per cent.)—which are not decreased or increased by increasing the phosphorus from 0.0

REFERENCES.

1 Hague and Turner. J.I.S.I., 1910 (II), p. 72.
2 Coe. I.B.F., 1910 (II), p. 163.
3 Coe. J.I.S.I., 1913 (I), p. 361.
4 Wüst and Meissner. Ferrum, January, 1914, p. 97.
5 Maurer and Holtzhaussen. St. u. Eisen, October, 1927.
6 Wüst and Kettenbach. Ferrum, November, 1913, p. 51.
7 Wüst and Stotz. Ferrum, 1914–1915, p. 89.
8 Coe. J.I.S.I., 1913 (I), p. 361.
9 Everest, Turner and Hanson. J.I.S.I., 1927 (II), p. 185.
10 Everest. F.T.J., August 25, 1927. Vol. 36, p. 169.
11 Stead. British Association, 1910.
12 Hatfield. J.I.S.I., 1913 (I), p. 39.
13 Wüst and Miny. Ferrum, 1917, V. 14, p. 97.
14 Piwowarsky and Schumacher. Die Giesserei, Feb. 10, 1926.
15 Adamson. J.I.S.I., 1906 (I), p. 75.
16 Coe. J.I.S.I., 1910 (II), pp. 105–146.
17 Coe. I.B.F., 1910 (II).
18 (*a*) Dickinson. Private communication.
(*b*) Shaw. Private communication.
19 Carpenter. J.I.S.I., 1911 (I), p. 224.
20 Taylor. I.S.I.C.S.M., 1926, p. 405.
21 Peace and Evans. I.B.F., July, 1928.
22 Shaw. A.F.A., 1926, Vol. 34, p. 810; A.F.A., May, 1928.
25 Shaw. A.F.A., May, 1928.
24 Evans and Peace. I.B.F., June, 1928.

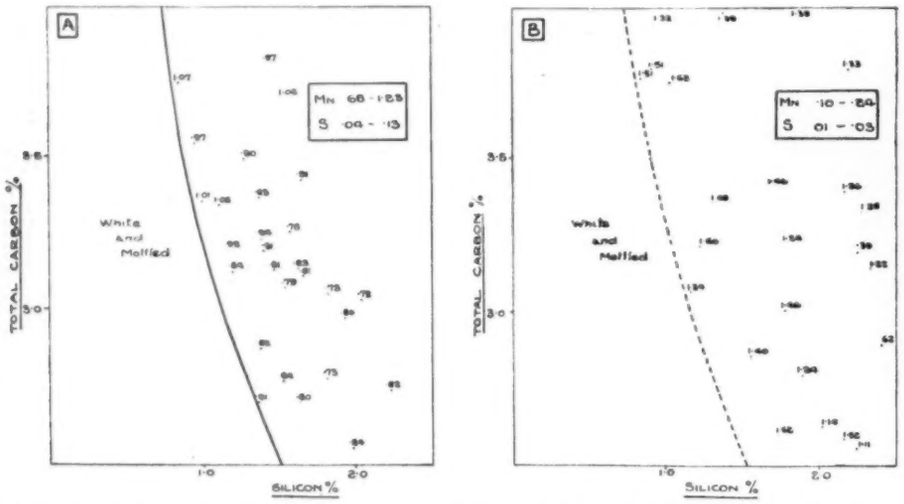
* A Paper presented to the recent International Foundrymen's Congress.

to 2.0 per cent. (A similar conclusion as to phosphorus results from a study of Coe's[8] data.)

Similar high combined-carbon contents in grey irons containing traces of manganese and sulphur and several percentages of nickel are evident in data published by Everest, Turner and Hanson,[9] and in grey irons containing traces of manganese and sulphur and several percentages of aluminium in data published by Everest.[10]

Microscopic Examination of Grey Cast Irons containing Low-Manganese and Traces of Sulphur.

Photomicrographs at 200 dias. of the grey-iron test-bars Nos. 1, 2 and 3 (Table 1) are shown in Figs. 3, 4 and 5 respectively. In these figures, the fall in combined-carbon from 1.29 to 0.54 per cent. is very marked. This fall is due entirely to the manganese content being increased from 0.02 to 0.33 per cent., the sulphur is constant at 0.03 per cent. and the silicon at 1.9 per cent. and the total carbon at 3.0 per cent.



Figs. 2A and 2B.—Combined-Carbon Contents of 1.2 Sand-Cast Bars of Various Total Carbon and Silicon Contents. Fig. 2A, with Mn 0.68-1.23, shows Normal Combined-Carbon Contents, while Fig. 2B, with Mn 0.10-0.24, shows Abnormally High Combined-Carbon Contents, Fig. 2A has been Constructed from Data published by Maurer, and Fig. 2B from Data published by Wüst and Kettenbach.

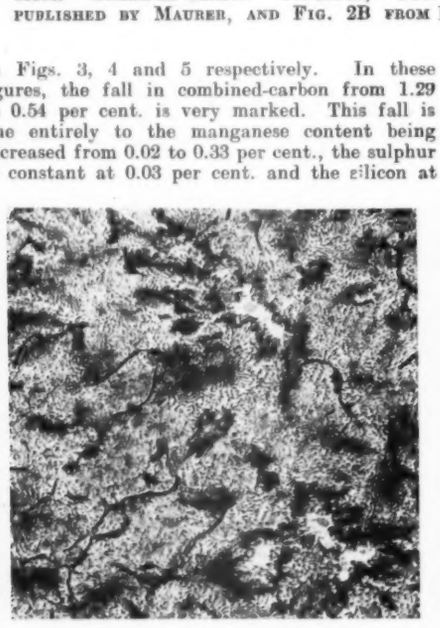


Fig. 3.—× 200. T.C., 3.0; Si, 1.9; S, 0.03; P, 0.03; Combined Carbon, 1.29, and Manganese, 0.02 per cent. White Lakes of Primary Cementite containing Iron Sulphide. Dark Patches of Secondary Cementite.

Fig. 3 shows the presence of three or four lakes of white cementite and numerous dark patches which, when magnified to 1,000 dias. as in Fig. 6, are seen to consist of cementite lamellæ much closer together than they are in pearlite. Such patches presumably consist of secondary (or pro-eutectoid or hyper-eutectoid) cementite. (The form of the secondary cementite in Fig. 6 suggests that it has been deposited at a single temperature instead of being deposited from the γ solid-solution continuously as the temperature on cooling fell from the eutectic temperature to the eutectoid temperature. In other words, the γ solid-solution containing about 1.2 per cent. combined-carbon has supercooled until the γ α allotropic-change temperature was reached, and this change caused the cementite to be deposited from solid-solution in a form which may be likened to pearlite with a combined-carbon content of 1.2 per cent. instead of the usual 0.9 per cent. The same thing probably occurred in the cast irons made by Hague and Turner,[1] since these investigators found only traces of thermal-arrests between the eutectic and eutectoid temperatures.)

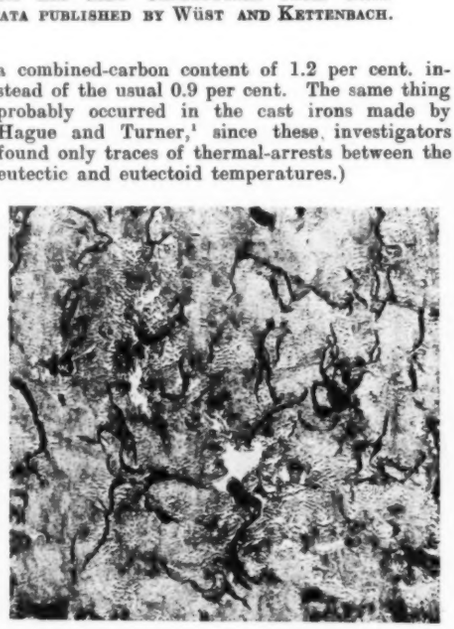


Fig. 4.—× 200. Same Composition as Fig. 3, except Combined Carbon 0.91, and Manganese 0.10 per cent. Less Primary and Secondary Cementite Present.

The white lakes of cementite in Fig. 3 contain islands of yellow iron sulphide. One of these magnified to 1,000 dias. is shown in Fig. 7. The sulphide was yellow in colour—in fact, similar in colour to a polished and etched specimen of iron sulphide. This indicates that the 0.02 per cent. manganese in this test bar (No. 1) is not combined with the sulphur, but is combined with some other constituent. It also suggests that these lakes of cementite have been prevented from graphitising by iron sulphide.

Fig. 8 shows another of these lakes at 1,000 dias., and in this case the lake contains fine spots of phosphide eutectic in addition to iron sulphide and austenite. (This indicates, incidentally, that the solid solubility of the phosphide in this particular iron must be considerably below 0.03 per cent. phosphorus—the figure found by chemical analysis.) These white lakes of cementite, etc., it is suggested consist of eutectic mixtures of iron carbide, austenite, iron sulphide and iron phosphide, plus secondary cementite which has been deposited on and has joined up with the primary cementite.

The fact that the specimen shown in Fig. 4 contains fewer lakes of primary-cementite and fewer dark patches of secondary-cementite than the specimen shown in Fig. 3 may be explained by assuming that the additional manganese it contains (0.10 per cent. instead of 0.02 per cent. Mn.) has combined with some of the 0.03 per cent. sulphur to form MnS which does not stabilise and form a eutectic with primary-cementite and does not stabilise secondary-cementite. Similarly, with the specimen shown in Fig. 5, the higher manganese-content (viz., 0.33 per cent. Mn.) has been sufficient to nullify any carbide-stabilising action of the 0.03 per cent. sulphur. It will be noted that between 0.10 per cent. and 0.33 per cent. manganese is required to effect this, and since 0.03 per cent.

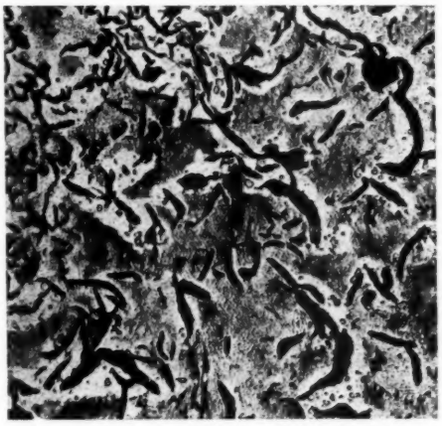


Fig. 5.—× 200. Same Composition as Figs. 3 and 4, except Combined Carbon 0.54 per cent., Manganese 0.33 per cent. No Primary or Secondary Cementite Present, and some Pearlite has Decomposed into Ferrite, plus Graphite.

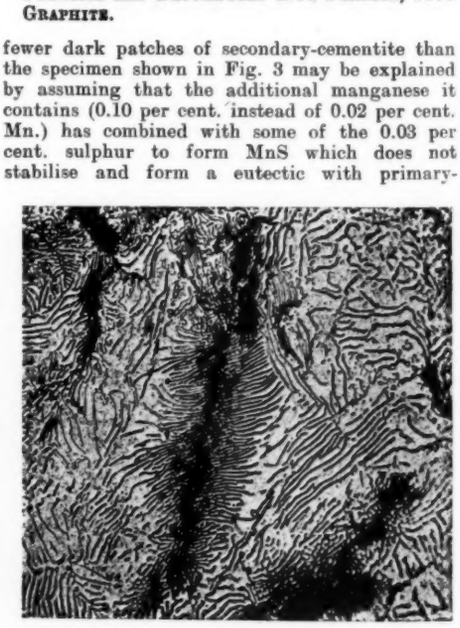


Fig. 6.—×1,000. Secondary Cementite Resolved. This Constituent Appears as Unresolved Dark Patches in Figs. 3, 4, 9 and 14.

sulphur only requires 0.05 per cent. manganese to form MnS, it follows that the manganese must distribute itself between the sulphur and some other constituent. Further additions of manganese up to, say, 1.5 per cent. of manganese have relatively little effect on the combined-carbon content, their tendency is to increase it slightly and to make the pearlite more sorbitic.

The fact that such small quantities—*e.g.*, 0.03 per cent.—of sulphur are sufficient to stabilise and prevent the graphitisation of such large quantities of combined-carbon (viz. 1.29 to 0.54 per cent.=0.75 per cent. combined-carbon) receives support from the work of Stead[11] and Hatfield.[12] Stead concluded that cementite can hold 0.1 per cent. sulphur in solid solution, and that such sulphur is mainly responsible—by making the carbide stable—for preventing the separation of graphite.

Effect of Sulphur.

All the data considered so far have referred to cast irons in which sulphur has been present only in traces, *e.g.* below 0.03 per cent. Wüst and Miny[13] cast a number of grey iron 1.2-in. dia. test-bars with sulphur varying between 0.01 per cent. and 0.3 per cent. and with manganese contents of 0.09, 0.64, and 0.85 per cent. Piwowarsky and Schumacher[14] added sulphur up to 0.8 per cent. to eutectic and hypo-eutectic cast irons containing 0.8, 1,8, and 2.8 per cent. silicon and 0.2 to 0.3 per cent. manganese. In both these researches, consequently, the sulphur was, except in one or two cases, greater than that required to form MnS with the manganese present, and the results are consequently outside the range considered in the present Paper. In order to investigate the effects of small excesses of manganese, above that required to form MnS, in irons containing appreciable amounts of sulphur, the following experiments were carried out.

Three 1.2-in. dia. grey-iron bars were cast in sand. The first contained 0.03 per cent. sulphur, the second 0.13 per cent. sulphur, and the third 0.28 per cent. sulphur; the manganese content was 0.5 per cent. in each case, the total carbon 2.8 per cent., the silicon 1.7 per cent., and the phosphorus 0.03 per cent. If the sulphur combines with the manganese to form a sulphide, its action should be equivalent to reducing the amount of manganese able to influence the combined-carbon contents, as above.

The results obtained indicate that this occurred, since as the sulphur was increased the combined-carbon contents increased (viz., 0.56, 0.72, and 1.18 per cent. combined-carbon respectively), even though the bars showed no signs of chill. The results are shown in Table II, where the amounts of manganese present, above that required to form MnS, have also been calculated.

Table II.—*Effect of small percentages of manganese and sulphur on the combined-carbon contents of 1.2 in. diameter sand-cast grey-iron bars.*

No. of test bar	9.	10.	11.
C.C.	1.18	0.72	0.56
Mn above that required to form MnS	0.00	0.28	0.48
Mn	0.47	0.50	0.53
S	0.28	0.13	0.03

T.C., 2.8; Si, 1.7; P, 0.03 per cent.

It will be seen that this assumption (that MnS is the sulphide formed) is approximately correct, since the combined-carbon content falls to normal when the "manganese above that required to form MnS" is between 0.28 and 0.48 per cent., a figure in approximate agreement with that already arrived at for irons containing only traces of sulphur. Further experiments are, however, being carried out to ascertain more accurately the excess manganese required.

The microstructure at 200 dia. of test-bar No. 9 is shown in Fig. 9, and is very similar in respect of its primary and secondary cementite contents to test-bar No. 1 shown in Fig. 3. This test-bar contained 0.47 per cent. manganese and 0.28 per cent. sulphur (the theoretical amounts required to form MnS), but the sulphide was khaki-coloured, indicating that it consisted chiefly of FeS, consequently the greater part of the 0.47 per cent. manganese present must be combined with some constituent other than the sulphur. A triangular crystal of the khaki-coloured sulphide in this specimen is shown in Fig 10 at 1,000 dia. magnification. It will be seen that this crystal shows an area of pearlite in its centre. It is not considered that this pearlite is the matrix showing through a hole in the sulphide, but that it is an inclusion, since its triangular shape is so definitely related to that of the crystal form of the sulphide. Test-bar 10 had a general microstructure similar to that shown in Fig. 4, while test-bar 11 had one similar to that shown in Fig. 5, except that the ground mass was pearlitic instead of pearlitic-ferritic.

Figs. 11, 12 and 13 show test-bars 9, 10 and 11 at 25 dia. magnification after deep etching in 1.20 sp. gr. nitric acid. The white networks are due almost entirely to cementite, since the test-bars only contained 0.03 per cent. phosphorus. The decrease in cementite as the manganese, above that required to form MnS, increases from 0.0 to 0.53 per cent., is clearly shown. The test-bars shown in Figs. 3, 4 and 5 gave similar cementite networks when etched in this manner.

Fig. 14 at 200 dias. magnification shows a malleable iron containing 0.20 per cent. manganese and 0.16 per cent. sulphur. It has been etched in boiling sodium picrate which darkens the cementite. The secondary-cementite is seen as dark centipede-like patches at the crystal boundaries. Its stability after the prolonged annealing is noteworthy.

The mechanical properties and complete analyses of the test-bars referred to above are given in Table 3. The bars were cast as follows:—About 50-lb. charges were made up of Swedish iron (T.C. 3.7; Si 0.3; Mn 0.05; S 0.03 and P 0.03 per cent.), Armco iron and ferro-silicon (11 per cent. and 40 per cent.), and melted in a Salamander crucible in a coke-furnace at 1,300 deg. C. to 1,400 deg. C., and poured at 1,350 deg. C. into green-sand moulds to give a 1.2 in. dia. bar, a 0.875-in. bar, a 0.6-in. bar and a 0.4-in. bar. Each bar was 16 in. long, was cast separately, and top-poured at an angle of about 30 deg. to the vertical. After casting a set of four bars, weighing about 10 lbs., the crucible was put back in the furnace, an addition of ferro-manganese made, and four more bars cast. All the bars in Series A were consequently cast from the same crucible full of metal with additions of ferro-manganese, similarly with those in Series B. In Series C additions of sulphur were made to the melt.

The bars were broken in transverse between 12-in centres. Drill-hardness tests ($\frac{7}{8}$-in. dia. drill) were carried out on the central core of each 1.2-in. bar. Brinell tests (10 mm./3,000 kg./30 sec.) were carried out on flat surfaces about $\frac{1}{4}$ in. below the surface of each 1.2-in. bar.

It will be seen in Table III that as the manganese increases and the combined-carbon falls, the Brinell-number falls, the drill-hardness falls, the tensile-strength falls in Series A where the third bar has a ferritic-pearlitic matrix (as shown in Fig. 5), but is little affected in Series B where the matrices of bars 7 and 8 are pearlitic (the low tensile-strength of 16.6 tons obtained on the last bar of Series B is largely due to the too-low temperature at which this bar was poured, while in Series C the high-S bar has given a low tensile-strength, possibly due to segregation). The transverse-strengths are little affected by variations in manganese and combined-carbon.

The shrinkage was measured by placing two pairs of pins exactly 14 in. apart in each mould (using a steel rod 14 in. long by $\frac{1}{4}$ in. dia.), so that the head and about $\frac{1}{4}$ in. of each pin projected from the face of the mould and became cast into the test-bars. The distance apart of the pins in the cold test-bars was measured with an internal micrometer-gauge. The shrinkage

Fig. 7.—× 1,000. Yellow Sulphide in White Lake of Cementite. Same Specimen as Fig. 3.

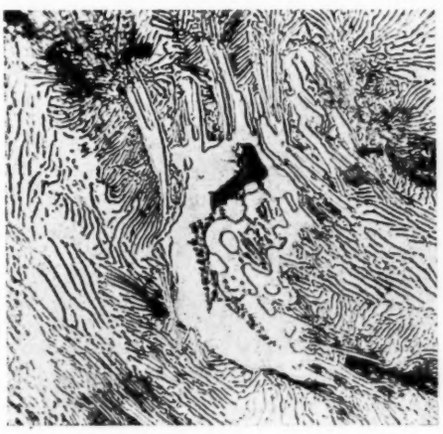


Fig. 8.—× 1,000. Dots of Phosphide Eutectic and Yellow Sulphide in White Lake of Cementite. Same Specimen as Fig. 3. P, 0.03 per cent.

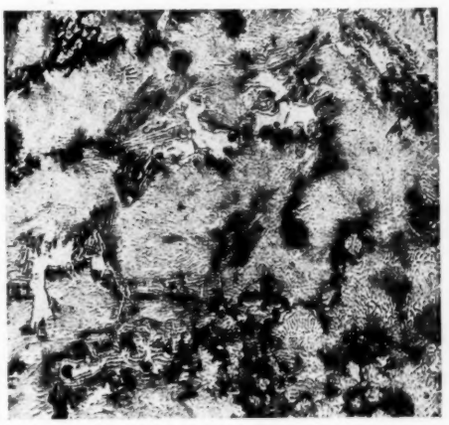


Fig. 9.—× 200. T.C., 2.8; Si, 1.7; Mn, 0.47; S, 0.28, and P, 0.03 per cent. Manganese (above that required to form MnS) 0.0 per cent., Combined Carbon 1.18 per cent.

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decreases as the manganese is increased and the combined-carbon falls. In the white and mottled bars the shrinkage is not affected. The tendency to chill or solidify mottled or grey is not markedly affected by the manganese-content in these particular tests.

Stabilising Action of Manganese on the Eutectic Cementite.

There is a considerable amount of evidence available that additions of 1, 2, 3 and higher percentages of manganese increase the tendency of cast iron to chill. Adamson[15] cast wedges 5½ in. × 1¾ in. × 5 in. high against a 3-in. steel block and found that increasing the manganese from 0.5 to 3.0 per cent. (in irons containing T.C. 3.3; Si 0.74 to 1.07; S 0.04 and P 0.04 per cent.) increased the depth of chill and mottle very markedly. Coe[16] found that increasing manganese from 0.5 to 30 per cent. in a grey iron containing T.C. 3.7; Si 2.4; S 0.3. and P 0.05 per cent., caused the iron to become mottled with 17.5 per cent. manganese and white with 30 per cent. manganese.

Coe[17] cast small ingots in an open chill-mould. The compositions were T.C. 2.8; Si 1.8; S 0.01; P 0.01 and Mn 0.03, 0.18, 0.37, 0.81, 1.05, 1.20 and 1.47 per cent. He found no appreciable chill in those ingots which contained less than 1.0 per cent. manganese, but definite and increasing amounts of chill as the manganese increased above this figure. Dickinson[18a] cast chill-wedges 5 in. × 1 in. × 5 in. high against a block of steel, and concluded that increasing the manganese from 0 to 0.14 per cent. decreased the depth of chill, while further additions increased the depth of chill.

Shaw[18b] cast a series of large and small wedge chills against a block of steel. The cupola-metal used contained T.C. 3.3; Si 0.75; Mn 0.36 and S 0.175 per cent., chills were cast and then increasing amounts of molten ferro-manganese were added to the ladle, chills being cast after each addition. The results are plotted in Figs. 15A and 15B, where it will be seen that the first and second additions of manganese caused a decrease in the depth of chill, while further additions caused a marked increase. The initial sulphur-content (0.175 per cent.) would require $\frac{0.175 \times 55}{32}$ = 0.30 per cent. Mn to form MnS. Consequently, there would be only 0.06 per cent. Mn above that required to form MnS in the original cupola-metal and this would account for the decrease in depth of chill caused by the first and second manganese addition.

Further confirmation of the chilling-action of manganese is given by the results plotted in Figs. 15C and 15D. Chill wedges 5 in. × 1 in. × 5 in. high were cast against blocks of cast iron. In the first series, Fig. 3C, the melt contained T.C. 3.0; Si 1.1 and S 0.03 per cent. Increasing the manganese from 0.22 to 0.4 per cent. decreased the depth of chill slightly, while further additions of 0.8 and 1.25 per cent. manganese increased it considerably. In the second series (Fig. 15D), the initial sulphur-content was made 0.15 per cent. (this would require $\frac{0.15 \times 55}{32}$ = 0.26 per cent. Mn to form MnS) and it will be seen that the first addition of manganese reduced the chill, while further additions increased the depth of chill, as before. Here again, the minimum chill is at approximately 0.3 per cent. manganese above that required to form MnS.

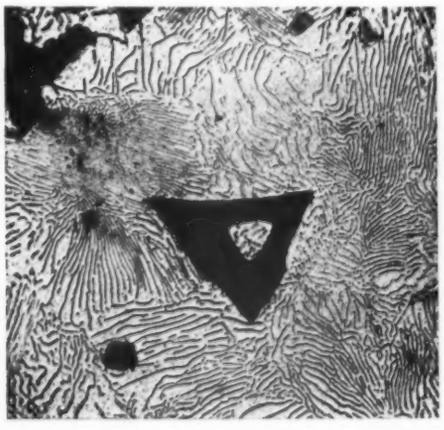


Fig. 10.—× 1,000. Khaki-coloured Sulphide Crystal, containing Pearlite. Same Specimen as Fig. 9. Mn 0.47, S 0.28 per cent.

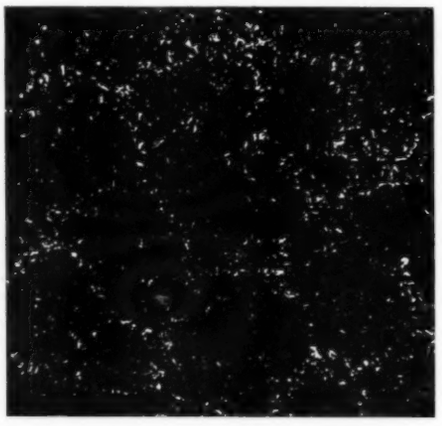


Fig. 12.—× 25. Same Composition as Fig. 11, except Mn (above that required to form MnS) 0.28 per cent., Combined Carbon 0.72, P 0.03 per cent. Less Cementite in Network than in Fig. 11 (Test Bar No. 10, Table II).

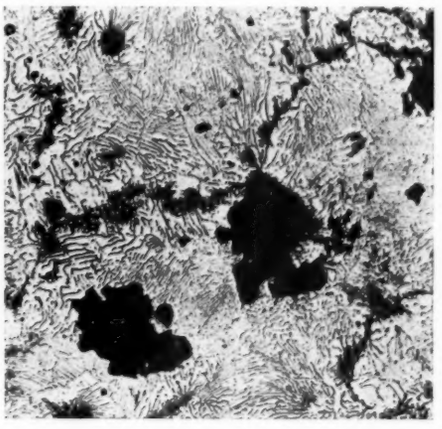


Fig 14.—× 200. Malleable Iron; Etched in Boiling Sodium Picrate. Darkened Secondary Cementite at Crystal Boundaries.

Stabilising Action of Manganese on Pearlite.

The following evidence indicates that manganese, if present in excess of that required to combine with any sulphur present, has a stabilising influence on the pearlite. Carpenter,[19] in experiments on the growth of cast iron, gave four bars containing 0.51, 0.74, 0.94 and 1.64 per cent. manganese, 151 heats at

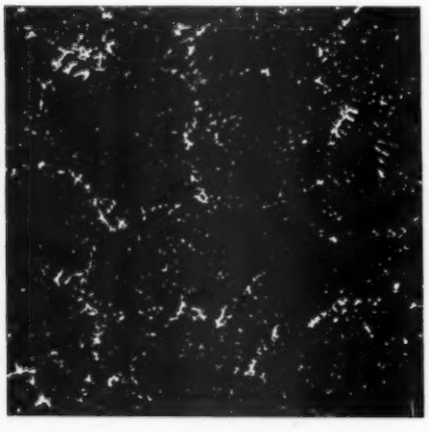
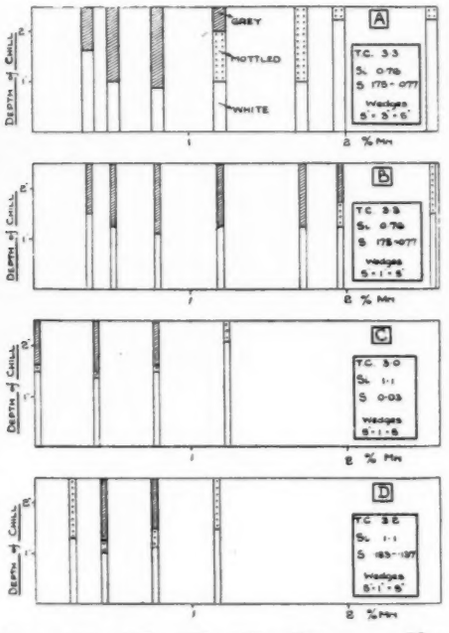


Fig. 11.—× 25. Mn (above that required to form MnS) 0.00 per cent., Combined Carbon 1.18 per cent., P 0.03 per cent. White Network of Primary and Secondary Cementite and Phosphide. Same Specimen as Fig. 9.

Fig. 13.—× 25. Same Composition as Figs. 11 and 12, except Mn (above that required to form MnS) 0.48 per cent., Combined Carbon 0.56 per cent., P 0.03 per cent. Little Cementite in Network (Test Bar No. 11).



Figs. 15A, 15B, 15C, 15D.—Effect of Manganese on Depth of Chill produced by Casting Wedges against Metal Chill. (Figs. 15A and 15B Constructed from Data Supplied by Mr. J. Shaw.) In Figs. 15A and 15B the Sulphur Content fell from 0.175 to 0.077, with Increasing Manganese, and in Fig. 15D from 0.153 to 0.137 per cent.

850 deg. C.-900 deg. C., and found that the stability of the carbide increased with increase in the manganese-content. Taylor[20] found in a series of malleable-irons containing manganese up to 1.3 per cent. that with increasing manganese-contents—above that required to form MnS—the annealed irons become more pearlitic and less ferritic. Peace and Evans,[21] referring to blackheart malleable, state "if the excess (above that required to form MnS) manganese is more than 0.25 per cent., the manganese retards graphitisation."

Summary.

Grey cast-irons which contain only traces of sulphur and manganese have abnormally high combined-carbon contents, *e.g.*, 1.3 per cent. Increasing the manganese from traces up to 0.3 per cent. causes the combined-carbon to drop to normal (*e.g.*, 0.8 per cent.) combined-carbon, and causes a decrease in the tendency to chill. Further additions of manganese up to 1 or 2 per cent. tend to increase the combined-carbon and increase the tendency to chill.

The explanation put forward is that the graphitising-action found on increasing the manganese from 0.0 to 0.3 per cent. is an indirect one due to the manganese combining with and nullifying the carbide-stabilising-action of traces of iron sulphide. It appears that about 0.3 per cent. manganese in excess of the amount theoretically required to form MnS is required to do this. Approximately the same excess of manganese, *e.g.*, 0.3 per cent., is required in irons containing higher sulphur-contents, *e.g.*, 0.1 and 0.2 per cent. sulphur. The high combined-carbon contents found in grey irons containing only traces of manganese and sulphur are due to hard-spots of cementite—austenite—iron-carbide eutectic plus secondary cementite, and to patches of secondary-cementite, stabilised in each case by traces of iron sulphide.

Apart from its indirect graphitising-action, due to its combining with and neutralising iron sulphide, the normal action of manganese is to stabilise iron-carbide and to increase the tendency to chill.

Table III.—*Mechanical Properties of 1.2-in., 0.875-in., 0.6-in., 0.4-in. Sand-cast Bars containing low percentages of manganese and high percentages of combined-carbon.*

	Series A.			Series B.					Series C.		
Test bar No.	1	2	3	4	5	6	7	8	9	10	11
C. Carbon per cent. on 1.2-in. bar	1.29	0.91	0.54	1.29	1.09	0.97	0.87	0.84	1.18	0.72	0.56
Mn above that required to form MnS	0.00	0.05	0.28	0.00	0.04	0.13	0.17	0.36	0.05	0.22	0.47
Mn	0.02	0.10	0.33	0.06	0.11	0.20	0.24	0.43	0.47	0.50	0.53
S	0.030	0.030	0.030	0.040	0.040	0.040	0.040	0.040	0.279	0.128	0.028
T.C.	3.02	3.06	3.05	2.79	2.78	2.77	2.76	2.75	2.79	2.79	2.82
Si	1.83	1.95	2.01	1.53	1.53	1.53	1.53	1.53	1.67	1.72	1.74
Brinell No. on 1.2-in. bar ..	285	241	201	269	255	255	241	229	285	255	241
Drill-hardness on 1.2-in. bar ..	80	70	54	—	—	—	—	—	—	—	—
Tensile-strength on 0.798-in. from 1.2-in. bar	15.0	14.4	12.7	20.0	18.0	19.5	19.8	16.6	6.9	21.0	19.0
Transverse-modulus of rupture on 1.2-in. bar (in tons/sq. in.)	20	20	20	28	31	29	28	27	29	31	27
do. on 0.875-in. bar ..	21	23	25	27	26	27	28	28	31	30	—
do. on 0.6-in. bar ..	24	27	29	36*	42*	40*	42*	47*	29	42	—
do. on 0.4-in. bar ..	32*	24*	41*	34*	30*	43*	35*	41*	29*	45*	42*
Shrinkage per cent. on 1.2-in. bar	1.4	1.3	1.1	1.3	1.1	1.1	1.0	1.0	1.0	1.2	0.9
do. on 0.875-in. bar ..	1.4	1.2	1.1	1.4	1.2	1.3	1.3	1.2	1.3	1.1	—
do. on 0.6-in. bar ..	1.7	1.5	1.2	1.7*	1.5*	1.7*	1.9*	1.8*	1.8	1.2	—
do. on 0.4-in. bar ..	2.0*	2.2*	2.0*	2.0*	2.0*	2.0*	2.1*	2.0*	2.0*	2.0*	2.0*

* Mottled or white.

Applications in Foundry Practice.

Numerous instances have been noted which show that many foundries adjust the manganese-contents of their castings to obtain certain results which are explainable by the above conclusions.

(A) *Chill Rolls.*—In chill rolls, the manganese (in excess of that combined with the sulphur present) is normally well-below the 0.3 per cent. excess manganese figure (a typical roll analysis would be manganese 0.3 per cent., sulphur 0.15 per cent.). Consequently further additions of manganese reduce the chill. This has been repeatedly emphasised by Shaw.[22]

(B) *Mechanical Strength of Grey Iron.*—Lowering the manganese-content of a grey iron below the 0.3 per cent. in excess figure, results in the substitution of cementite and pearlite for some of the graphite, ferrite and pearlite. This is equivalent to introducing a hard brittle-constituent similar to iron phosphide, but at the same time reducing the graphite-content. The net effect is that the tensile and transverse strengths are not greatly affected in pearlitic irons but may be increased in pearlitic-ferritic irons.

(C) *Hard-Spots in Grey Iron.*—If the manganese-content is sufficiently low to allow the presence of hard spots of cementite, and patches of secondary cementite, the iron will be much harder and more difficult to machine. High-sulphur in the presence of low-manganese will give the same result.

(D) *Resistance to Wear.*—A low-manganese grey iron containing hard spots of cementite in a pearlitic-matrix should show good resistance to most types of wear.

(E) *Corrosion-Resisting Irons.*—A low-manganese iron containing cementite embedded in pearlite should be more resistant to most types of corrosion than one containing a more graphitic and ferritic matrix.

(F) *Shrinkage in Grey Iron.*—If the manganese (in excess of that combined with sulphur) is sufficiently low to increase the combined-carbon there will be a corresponding increase in the total-shrinkage.

(G) *Experimental Melts.*—Shaw[23] has pointed out that grey irons made synthetically from Swedish or American washed-iron usually contain much higher combined-carbon contents than those obtained in foundry practice. The high combined-carbons may be explained by the low manganese-contents of these pig-irons.

(H) *Black-heart Malleable Iron.*—Evans and Peace,[24] referring to black-heart malleable, state "the manganese must be present in sufficient quantity to neutralise whatever quantity of sulphur is present. The amount is not, however, the theoretical requirement to form manganese sulphide, *i.e.*, 1.72 times the sulphur-content, but is in excess of this. Actual practice has established that the excess required increases with the sulphur-content. With 0.04 per cent. sulphur the excess required is in the neighbourhood of 0.20 per cent. manganese. If the excess is more than 0.25 per cent., the manganese retards graphitisation."

(I) *White-heart Malleable.*—In white-heart malleable, the process depends on the removal of the carbide by decarbonisation, rather than on its graphitisation (as in the black-heart process), consequently high sulphur, *e.g.*, up to 0.3 per cent., may be used, and though detrimental of itself, has an indirect beneficial action in so far as it stabilises the carbide and prevents its graphitisation.

Acknowledgments.

The present investigation has been greatly assisted by consideration of castings sent to the British Cast Iron Research Association by its members for examination, and by discussions with its Director and the author's colleagues, and the members of this Association. The photomicrographs were taken by Mr. L. W. Bolton, the analyses carried out by Mr. C. Rowley, and the mechanical tests by Mr. H. G. Clarke. Thanks are due to Messrs. A. S. Smith & Sons, Walsall, for facilities for casting the test-bars; to Averys, Limited, Soho Foundry, for facilities for transverse-testing; to Messrs. Belliss & Morcom, Limited, for carrying out the drill-hardness tests; and to the Council of the B.C.I.R.A., for permission to publish the present Paper.

Committee of Inquiry into the Iron and Steel Industry.

It is announced that the inquiry into the iron and steel industry will be carried out by a sub-committee of the Committee of Civil Research. This sub-committee consists of two members of the Cabinet, a leading industrialist, a prominent trade unionist, and an accountant, namely, Lord Sankey (the Lord Chancellor), Mr. A. V. Alexander (First Lord of the Admiralty), Sir Cecil L. Budd (chairman of the London Metal Exchange and managing director of the British Metal Corporation, Limited), Mr. C. T. Cramp (Industrial Secretary of the National Union of Railwaymen), and Sir William Plender (senior partner of Deloitte, Plender, Griffiths & Company).

The terms of reference of the sub-committee will be:—To consider and report upon the present condition and prospects of the iron and steel industries and to make recommendations as to any action which may appear desirable and practicable in order to improve the position of those industries in the markets of the world.

Contracts Open.

Braunton, Devon, August 31.—300 yds. of 3-in. cast-iron pipes, for the Rural District Council. Mr. J. C. Southcombe, Cross Street, Barnstaple.

Hull.—Poles, cable, copper trolley wire, malleable cast and steel pole arm fittings, etc., for the Tramways Committee. The General Manager, Tramway Offices, Albion Street, Hull.

London, S.E., August 13.—Forty metre-gauge locomotives, for the India Store Department, Belvedere Road, Lambeth, London, S.E. (Fee 5s., non-returnable.)

Lourenco Marques, September 2.—One locomotive and tender, one closed wagon of 20 tons, and accessories, for the Treasury Department. The Department of Overseas Trade. (Reference A.X. 8,252.)

Simla, August 12.—Power-driven bucket elevators, for the Indian Stores Department, Engineering Branch, Simla. The Department of Overseas Trade. (Reference A.X. 8,267.)

Wareham, Dorset, August 12.—28-b.h.p. cold-starting-type heavy-oil engine, and 1-kw. electric lighting and power plant, for the Urban District Council. Mr. W. E. Blizard, Castle Lane, Southampton. (Fee £2 2s., returnable.)

Messrs. David Brown & Sons, Limited, of Huddersfield, have acquired a licence for the "Shorter" process for the surface hardening of gears of all kinds, and have installed a complete plant.

Reorganised Textile Foundry Inspected.

On Saturday, July 6, responding to the invitation of the Chairman and Directors of Messrs. John Hetherington & Sons, Limited, about 85 members of the Lancashire Branch of the Institute of British Foundrymen visited the Vulcan Works in Pollard Street, Manchester, where Mr. E. Longden, the Branch-President, is the foundry superintendent. Splendid arrangements had been made for the reception and entertainment of the visitors, who were received by Mr. J. F. Innes, Technical Director; Mr. J. Wright, Works Manager, and Mr. Longden himself. In a brief address of welcome Mr. Innes said the directors would be glad to know their invitation had been accepted by so many. They regarded it as an honour in which the firm shared that Mr. Longden had been re-elected Branch-President for the second year. Under his supervision great improvements had been made and planned in the foundry, and though the work was not yet completed, sufficient had been done to enable the visitors to see what was aimed at, and to realise what was likely to be accomplished. It was intended to make it the finest foundry in the country.

Genesis of the Foundry.

After being marshalled into groups the visitors were conducted through the various departments. The Vulcan Works is devoted to the production of textile machinery, but the foundry also turns out the castings for machine-tool production at the firm's adjacent Ancoats Works. Formerly, the firm also carried on under the same directorate, but with separate management, the Phœnix Works, nearby in Chapel Street, which were closed down a few years ago in pursuance of a policy of concentration and extension. Careful consideration was given to the alternative of going outside the Manchester city area and carrying on operations in a low, extensive building instead of turning to fuller account the advantages of the Pollard Street site by adding additional storeys to part of the existing buildings and using for the engineering and foundry shops space previously vacant or used for storage purposes. It was decided to take the latter course. A strong argument for such a course was that modern developments have simplified the problems of transport and handling of materials within a works of this size.

The first stage in the scheme of concentration was the erection of new machine shops on what had formerly been yard space and one of the foundry departments. This happened about four years ago. Mr. Haigh and Mr. Longden then gave attention to the reorganisation of the foundry. Visits were made to the most important foundries in England, and Mr. Longden, who attended the 1927 International Congress of Foundrymen in America, availed himself of his opportunities there to study the best American practice. Among the works he visited were the Ford Motor Works, Detroit; Worthington Pump and Machinery Company, New York; William Sellars & Company, Machine Tool, Philadelphia; the Johnson & Jennings Company, Cleveland; Link Belt Company, Chicago; Chicago Steel Foundry, Chicago; Carnegie Steel Company, Pittsburg; Admiralty Dock Yard, Philadelphia; the Baldwin Locomotive Works, Philadelphia; and the Westinghouse Company, Pittsburg, etc.

Reducing Transport Costs.

In the application of the lessons so learnt regard was had to two important factors, improvement in methods of transport and conveyance, and the lessening of manual labour. The old systems were to dump in the yard the material needed for the cupola—the pig-iron, the coke, the limestone. These materials now arrive at the works in special containers and cradles and are picked up by an electric crane from the transport vehicles and conveyed direct to the cupola stage, which is 325 ft. long by 25 ft. wide. There are four cupolas, one equipped with the Poumay system of control, and one in course of alteration. No other foundry in Lancashire has yet installed this modern cupola. Great economies in fuel consumption have been obtained in the non-ferrous foundry from the substitution of the Morgan Tilting Crucibles furnaces for the old-fashioned pit-fires. Another favourable point is that it is less laborious. This consideration has also led to the more extensive use of aluminium pattern-plates. Their lightness in comparison with the cast-iron patterns becomes a material factor in the course of a moulder's day's work.

The new foundry held great attraction for the visitors, and there they spent much time. But there were other things to interest them, for the excellent show-room, which has an area of approximately 120 ft. by 65 ft., contains machines for every process through which cotton passes in the course of conversion into yarn; they begin with the bale-opener and proceed with machines for combing, drawing, twisting, etc. Spinners take advantage of these facilities to have tests and experiments made here instead of in their own mills, where machines might have to be altered for the purpose. Messrs. Hetherington supply machinery for both ring-spinning and mule-spinning.

In addition to cotton-spinning machinery, the firm supply machinery required in the manufacture of woollens and worsteds. Special machines have been installed and built to meet the demands of the artificial-silk trade. Three mills for that purpose have been equipped recently with special machinery, all of which are now producing excellent yarns. There are very considerable and growing demands for the artificial silk machinery, and Lancashire is proud of the pioneer work of John Hetherington & Sons in producing such machinery.

Progress was reported in the grinding and glazing department. Special carborundum stones which cost £70 to £80 apiece have been substituted for the sandstones, which previously cost £10 to £12. Of course, the former have a much longer life, but the chief consideration is that the conditions are made healthier for the workmen.

A Social Evening.

A substantial tea, followed by a smoking concert, was provided by the hospitality of the firm. Mr. F. J. Innes presided, and after giving the toast of "The King," called upon Mr. G. W. Nasmith to propose "The Lancashire Branch of the Institute of British Foundrymen." Mr. Nasmith said Mr. Haigh, the Managing Director of the firm, took a great interest in industrial science, research work, and the diffusion among the workmen of the knowledge so gained. Those being the purposes which the Institute served, it was a great pleasure to welcome its members. The Lancashire engineering industry was already under obligations to the Institute for services rendered in that way; the debt would be enhanced in the future by the co-operation which was required in order to maintain the prosperity of this country. Messrs. John Hetherington & Sons had a special motive for appreciating the work of the Institute in that they had on their staff Mr. Longden, the Branch-President.

Mr. R. W. Stubbs, Vice-President and Managing Director of Messrs. Stubbs, Limited, replied to the toast. He remarked that he went through the Vulcan Works three or four years ago and what he had seen on this occasion showed that enormous progress had been made. It was a testimony to the energy of Mr. Longden. He thanked Mr. Nasmith for his kindly reference to the Lancashire Branch. It was indeed one of the most progressive in the Institute and had approximately 300 members. Its Junior Section was doing admirable work.

Mr. Jolley, Foundry Manager of Metropolitan-Vickers, proposed the toast of "John Hetherington & Sons, Limited." He said the firm had a history of a hundred years and stood in the forefront amongst makers of textile machinery and machine tools. Their enterprise was shown in providing for the new industry, artificial silk. Instead of taking their own line and muddling through they tackled the job in a proper scientific spirit and brought in experts to advise them and point out pitfalls to be avoided. In the course of this visit he had observed many things which revealed enterprise and forethought, and they were undoubtedly going to save money in the foundry departments.

Reference had been made to the debt owed by engineers to foundrymen. Personally, he considered foundrymen had reason also to feel thankful for what engineers had done for them. Co-operation and co-ordination were increasing. He observed that, in every up-to-date engineering establishment that he visited, the foundry was becoming recognised. Visits of this kind were valuable educationally as well as being interesting, and for that reason he regretted that there were not more of their young men present on this occasion. He therefore urged each of his listeners to endeavour to bring with them to the other works visits the younger members of the Institute.

The Chairman said John Hetherington & Sons, Limited, prided themselves on what they did in the cause of technical education. They had been commended by the authorities for it, and during the winter, approximately every three weeks, the foremen attended on Saturday afternoons to conduct two or three parties of students through the works.

In proposing the toast of "The Branch President," Mr. J. O. Gray praised the work which Mr. Longden had done in improving the foundry equipment of the works. Great difficulties had been overcome. In his contributions to foundry science and practice Mr. Longden had done international service which had been highly appreciated.

Mr. Longden replied, and said it was a feature of Hetheringtons that every man had a chance to prove his ability. He was encouraged to put forward suggestions which were given the most careful consideration by Mr. Haigh and the directors. Comparing this state of things with his own early experience to gain education, he was impressed by the great change which had taken place. He remembered having to leave a convenient place of employment because a stupid foreman refused to allow him convenience to attend evening classes. This sympathetic attitude to the education of the young men in the engineering trade was certainly wise and would help materially to develop the industry. Opportunities should be given to put into practice ideas which were discussed at the Branch meetings of the Institute of British Foundrymen. A new type of foundry technical man was coming into existence—the foundry engineer, who combined the practical training of the foundryman with the scientific and theoretical knowledge of the engineer. He believed that the future held great possibilities for that class of technical man, because hitherto the lack of engineering training on the part of the foundryman had compelled too much theoretical development by the engineer for the foundry.

In the musical entertainment Mr. Thompson presided at the piano. Mr. R. Carey contributed violin solos, and the vocalists were Messrs. L. Hemsley, M. B. Lees, F. Redmond, J. Booth and H. Howard.

The meeting concluded with the usual vote of thanks to those responsible for their entertainment.

Messrs. Hawthorn, Leslie & Company, Limited, of Hebburn, have booked an order for the hull and engines of a coasting steamer, 250 ft. in length, for the Union Steamship Company, of New Zealand.

Some Inter-Relationships in Grey-Iron Metallurgy.*

By W. J. Bolton (U.S.A.).

This Paper, which was presented on behalf of the American Foundrymen's Association to the International Foundry Congress, was introduced by Mr. Dan Avey, who also expressed regret that Mr. Bolton was unable to be present at the Congress.

DISCUSSION.

Future of American Research Forecast.

MR. R. S. MACPHERRAN (U.S.A.) said the day would come when there would be a correlation of bulk with the surface of castings. The American Foundrymen's Association was working on this matter, and a report of the Committee dealing with it would be presented in due course.

MR. R. F. HARRINGTON (U.S.A.), referring to the trepanning of specimens and the attempt to correlate the results of tests on bars taken from the castings and on cast specimens, said it was becoming more fully realised that it was necessary to use larger test specimens than had been used hitherto, in order that the results obtained might be more strictly comparable. He anticipated that the American Foundrymen's Association would be able to shed some more light on that particular subject. He was glad that Mr. Bolton had emphasised above all the fact that they had to sell castings, and not test-bars, and that they were concerned to turn out proper castings by the adoption of sound foundry methods.

MR. J. T. MACKENZIE (U.S.A.) said that the work of the American Foundrymen's Association Committee on grey cast iron was concerned with the examination of the properties of the iron in the molten state, with the idea of determining the properties which made for the production of sound castings or otherwise. They had just completed some work of considerable magnitude on the determination of the temperatures, and had shown up the faults of the optical pyrometer in that regard. Following that, they were engaged upon a study of the shrinkage of cast iron in the freezing range; if they were successful in developing a test for that, it would be extended to the contraction from the freezing point to room temperature, which would include shrinkage as we now know it. He could not emphasise too strongly that the soundness of the casting had more to do with the quality of the cast iron than with the tensile strength of the test-bar.

PROFESSOR T. TURNER (late Professor of Metallurgy at the University of Birmingham, and Past-President of the Institute of Metals) acknowledged that the results put forward in the Paper represented a very considerable amount of practical work, and combined with it an attempt at scientific correlation. In earlier investigations of subjects of this kind we had been content to say that a thing was good or bad, or very good or very bad, and we had had no quantitative values. We did not become scientific until we could express many of the properties in figures; at the same time, if we did use figures, we must be very careful that those figures were correct, because there was nothing more misleading than a wrong figure. We had recognised for many years the importance of the rate of cooling of a casting; the attempt to correlate bulk with surface—which, of course, determined the rate of cooling—was very interesting, and one felt that Mr. Bolton had made a considerable advance in that direction. Commenting on Mr. Bolton's reference to the value of crucible-cast synthetic mixtures, he said that every scientific man recognised that those could not correspond accurately with what obtained in practice, in view of the many variables that entered into the problem in practice, but the great advantage of the study of the synthetic mixtures was that we were able to eliminate a number of the variables and to study one thing at a time. Having learned one thing among a number, we could gradually find the wider truths.

Graphite should be Scientifically Classified.

Referring to the question of graphite, he said the author had stated that the control of the amount and form of graphite was more important than the control of the matrix alone. In connection with the amount and form of graphite, however, we had no quantitative value. The form of graphite was sometimes very fine indeed, like that of soot; some of it was in the form of curved flakes, and some was in the form of flat flakes. Those were simple kinds of graphite, but there were also intermediate qualities, each of which corresponded to entirely different physical properties in the material, and when describing graphite we should endeavour to state to which class it belonged, or whether it was a mixture of more than one class. Ledebur, who was a pioneer in this work, had pointed out the importance of the finely-divided graphite. But what did we mean by "finely-divided graphite"? Some of it was very small, and could be seen only with the aid of a microscope of very high power, whilst some was in the form of flakes almost as large as one's finger-nail; there were other sizes between these two extremes, and we ought to have some method of classification. Some years ago he had classified graphite by extracting it, purifying and drying it, and passing it through sieves, and recording that so much went through a sieve of one size and so much went through another size. That was a slow and cumbersome process, and we ought to be able to classify graphite microscopically, and to say, for instance, that some of it was larger than 0.05 in., and that size we might consider to be large. There were various grades above that, however. Some graphite was smaller than $\frac{1}{200}$ of an inch (0.005). We might classify in terms of millimetres. Graphite larger than 1 mm. we might call coarse in an ordinary casting, and we might classify down to sizes as small as 0.01 mm. Whatever the classification adopted, however, we ought to have some method, not merely of classifying graphite as being coarse or fine or intermediate, but of stating that the bulk of it was of a certain definite size; then we should be able to compare the results obtained by one investigator with those obtained by another.

When Gas in Metal is Dangerous.

With regard to gas, he was glad that the author did not regard it as serious, comparatively speaking. The effect of gas was serious if that gas happened to come off during the process of solidification so as to give rise to blow-holes or spongy masses, which would deteriorate the casting, but otherwise the casting seemed not to be effected, whether the metal was melted in an atmosphere containing one gas or another. It was somewhat analogous to aerated water. When aerated water was enclosed in a corked bottle, it looked like ordinary water, but when the cork was removed there was considerable effervescence. During the cooling of a metal containing a gas in solution the gas came off, and it was for the founders themselves to ensure that that gas came off quietly and did not cause bubbles; so long as it did not come off in bubbles he did not think they need worry about gas.

The French View-Point.

M. E. V. RONCERAY (France) expressed the view that the Paper was a condemnation of the use of test-pieces cast separately from the actual castings. He was glad to note that the author attached great importance to the soundness of castings, because at the Foundry High School in France the students were taught that the factors which were of the greatest importance were (1) soundness, (2) tensile strength or internal strain, (3) strength of material, and (4) cost. It would be noted that strength was placed third in order of importance, and that soundness was placed first. The problem of internal strain was very important, because very often strains existed where they were not expected, especially in cast iron, and there were no scientific means of finding out what stresses existed in castings. A casting might be sound, and it might also be made of strong material, but even so it might be worth nothing. In a Paper by the President of the Académie des Sciences, it seemed to be proved that these troubles could be overcome by certain heat treatment. If that were proved by prolonged experiment, we should have made a great step forward. With regard to the Frémont test, it seemed to be the view of many people that this was a shear test. The French Foundry Technical Association had taken the trouble to print an issue of its "Bulletin," in which was concentrated all the Papers that had been published with regard to this question, and if those Papers were read carefully it would be appreciated that the shear test was only one part of the Frémont test. The ideal test was a bending test on a small sample taken from the casting. Mr. Bolton had commended the ball test, not as a final test, but as a test of heterogeneity of the castings. There was a tendency, however, to try to link all the tests together, but it was well known that there was no definite connection between the ball test and the tensile test, for instance. It appeared also that difficulty had been experienced in taking small samples from castings, but those who would take the trouble to read the Paper by MM. Le Thomas and Bois on cast-iron testing methods, which Paper was to be presented to the Congress, would find that there was absolutely no difficulty in that respect. The proof of that was that the process described in that Paper had been adopted by the French Navy a few weeks ago, after a three-years' test.

Melting Conditions of Paramount Importance.

MR. J. G. PEARCE (British Cast Iron Research Association) said that the author had placed all foundrymen in his debt by collecting together the factors which influence the properties of the capricious conglomerate called grey iron, as he had done in this and his A.F.A. Paper at Philadelphia in 1928. It was particularly useful to have the author's results on a clearly-defined set of experiments, because work on a haphazard collection of tests did not make for scientific conclusions any more than stringing together a collection of letters made words or of words, understandable English. Everything lay in the selection of the tests and the arrangement of the results.

He said he could confirm without hesitation the importance of the melting conditions, by which he meant those conditions of charge-constitution and furnace-running which affected the structure, and hence the properties of the metal other than the chemical composition itself. Referring to the problem of volume—surface-area ratio—he said he had carried out some work on the mechanical properties of cylindrical bars, and had tried to relate the strength of bars of different thicknesses to the diameter* and equations to the curves could be readily worked out. They would, however, differ for each iron. The cylindrical bar was a very simple casting, and if one excluded the ends of the cylinder, which were comparatively unimportant, the ratio of

* See our Issue of June 13, page 449.

* See "Influence of Size of Section on Strength of Grey Cast Iron" presented to the Convention.

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volume/area was proportional to the diameter. The ratio would work in simple cases, but in the more complicated cases he was not so optimistic. If one cast a flat plate, it would have a certain volume/area ratio. If one cast it as a double plate, *i.e.*, with one-half turned over on to the other half, sandwich fashion, the ratio would remain the same, but obviously the two halves of the plate would affect each other in cooling, and the structure of the metal would be different. Thus, the test results would be altered very seriously, and he could not see how Mr. Bolton accounted for the influence of adjacent masses in a casting. This applied to all cored castings. He (Mr. Pearce) was proposing to proceed from a consideration of simple castings, such as cylindrical bars, to slightly more complicated castings, such as liners and piston pots, and not immediately to the more complicated cored castings such as Mr. Bolton had considered. These considerations made him less optimistic than the author with regard to the use of the volume/area ratio. Mr. Fletcher had used its reciprocal in 1918,* and Keep used it as far back as 1895.† No very striking developments, however, had originated from it. Again, he (Mr. Pearce) had used the transverse test, which could be applied at or very near to the cast-size of the metal, and he had tried to relate that to the tensile, compression and other tests. Mr. Bolton was compelled to machine his tensile and shear bars to a comparatively small section, below the main sizes of the test-pieces. This, of course, affected the strength. He would also be limited in the section of the bar he could actually test. Transverse tests up to 5 in. thick presented no difficulty, but tensile and shear tests at this diameter did so. It would help if Mr. Bolton would give details of the shear test he used. Presumably his "calculated" tensile results were based on bars cast the next day, having a cooling ratio as close as possible to the casting which he was actually examining.

In conclusion, he said that British foundrymen would very warmly reciprocate the sentiments expressed in the concluding paragraph and look forward to an increased interchange of information in future.

Mr. W. Jolley, in a tribute to Mr. Bolton, and in thanking him for having given in his Paper a tremendous amount of information which would be of great value to foundrymen, said that the differences between the results obtained in the laboratory and in the foundry were sometimes very wide, and Papers such as this, which assisted foundrymen in the correlation of their test results so that the properties of their castings might be predicted, were of extreme value.

Raw Materials have their Significance.

Mr. J. E. Fletcher (Consultant, British Cast Iron Research Association), after paying a tribute to the American foundrymen for their wonderful work on correlation, said that the Research Association had been trying to correlate as far as it could the various properties of cast iron as influenced by cooling rate and composition. There was one phase of this subject, however, which was often left out of consideration, namely, the effect of variable conditions during the making of the foundrymen's raw material, pig-iron, in the blast furnace, which influenced in such a serious fashion the ordinary casting. Most practical foundrymen were only too conscious of the fact that irons of the same analysis, when used in a cupola, often gave different results. This matter had been touched upon by one of our American friends this year, and some valuable work had been done in this connection. He was one of those who believed that the conditions at the beginning of things had a great deal to do with the results obtained at the end, and he suggested that the Institute should try to obtain from the blast-furnace people a good deal more information than they had hitherto vouchsafed to the foundrymen. He was very glad that Mr. Bolton had given particulars of an actual casting at the end of his Paper, because, after all, it was the final casting that mattered. Also, he was glad that it was a fairly thick casting, because in the case of a thin casting the cooling ratio was fairly easy to apply.

Chemical Composition and Mechanical Properties may be Unrelated.

Mr. John Shaw said the Paper was founded upon two clear ideas: First, to classify irons into various grades of composition, and secondly, to correlate the physical properties of these grades when melted and cast under known conditions. For the purpose of the latter he had sub-divided the factors influencing mechanical and physical properties of grey cast iron under four headings, (1) chemical composition; (2) structural, mechanical and chemical make-up of charge; (3) the melting process; and (4) the thermal and mechanical history from furnace spout to finished casting. This was a very large order. If, to the specified grades in Table I, there were added the four types of phosphorus content, one arrived at a figure of 200 compositions, and many still believed that full knowledge would not be obtained until some such scheme was tried out. The importance of the first three headings of the sub-division was not fully recognised. Some very illuminating work had been carried out recently by Mr. Jolley and his staff, and it was to be hoped that Mr. Jolley could be persuaded, in the near future, to present a Paper showing the various structures and the methods of obtaining them.

The following table contains three examples, from the bottom, middle and top of a table containing 53 examples:—

Effect of Cupola Conditions and Steel Additions on Physical Properties.

Tensile. Tons/sq. in.	Shear. Tons/sq. in.	T.C.	Si.	T.C.+Si.	T.C.+$\frac{Si}{3}$	Shear Ten.	C.C.	Mn.	S.	P.
9.8	16.8	3.44	1.56	5.00	3.91	1.71	0.59	0.68	0.11	0.64
10.0	16.2	3.46	1.60	5.06	3.94	1.62	0.56	0.65	0.114	0.48
10.9	18.2	3.41	1.93	5.34	3.99	1.67	0.51	0.76	0.103	0.58
13.4	20.0	3.43	1.49	4.92	3.88	1.49	0.63	0.71	0.113	0.64
13.5	19.9	3.44	2.03	5.47	4.05	1.47	0.49	0.72	0.089	0.86
14.9	20.4	3.43	1.98	5.41	4.02	1.37	0.53	0.74	0.110	0.61
17.6	24.5	3.35	1.49	4.84	3.80	1.39	0.60	0.76	0.12	0.51
18.1	27.0	3.36	1.47	4.83	3.80	1.49	0.56	1.20	0.103	0.58
18.8	18.6	3.40	1.91	5.06	4.00	1.00	0.58	0.72	0.116	0.76

The chemical composition was practically the same, yet the tensile results varied nearly 100 per cent. The bars were all of the dimensions 14 in. by 1 in. by 1 in., so that the surface area and volume was the same. These results were obtained by varying cupola practice, and altering charges and casting temperature. Other factors might affect the physical properties, but these experiments had thrown much light on some of the reasons why chemical analysis did not always fall into line with physical tests. The expression of the relationship of volume to surface area in definite terms was a new idea, and would bear testing out. One did not realise at first glance that if one had, say, a block of iron 4 in. by 4 in. by 10 in., and transformed this into a plate 16 in. by 10 in. by 1 in., the surface area was increased from 192 sq. in. to 372 sq. in., while the volume remained the same. This would give a different factor for each, that might relate each to its proper bar structure. There were objections to this, however. In a large and complicated casting there might be widely varying sections, and to calculate surface area and volume of such a casting was not a simple matter; the figure obtained would be an average, and, after all, one would use an average composition for such a casting, probably erring on the hard side for the thin portion, to allow for the annealing effect of the heavier section.

Referring to the test-results relationship, he said he would not care to accept the tensile result of a bar of the same composition as the casting, if that bar had not been cast out of the same ladle of metal; neither would a shear result converted into a tensile be acceptable. Whilst it might be granted that under the very closely controlled conditions specified by Mr. Bolton, approximations in both cases were possible, and their use for works information and research of great value, these approximations would not be acceptable to the buyer of the casting. It must be remembered that in many cases the inspector or buyer had only the one or two simple tests to rely on to give him some idea of the physical properties of the material. Finally, Mr. Shaw said that those who had read this Paper, together with the one presented on the same subject a year ago, could not but be grateful to Mr. Bolton for the great amount of work he had done and for the valuable information he had imparted.

It was intimated that Mr. Bolton would reply in writing to the discussion.

Vote of Thanks.

The President (Mr. Wesley Lambert), proposing a vote of thanks to Mr. Bolton, said that he would be gratified by the discussion it had evoked. The President agreed with the view that, apart from the tensile strength or any other mechanical-strength figures relating to a casting, the most desirable thing was to have a sound casting, free from internal stresses. The buyer wanted a casting which he knew to be sound and free from internal stress, but it was also necessary to know the strength, to enable the designer to design his parts; therefore, any attempt to correlate the information obtainable by any means was of value. He proposed, formally, a hearty vote of thanks to Mr. Bolton for his Paper and to Mr. Avey for having presented it.

Mr. J. G. Pearce, who seconded, said he looked forward to the opportunity of studying the Paper, together with the discussion upon it, when published.

The vote of thanks was carried with acclamation.

* Journal, Iron and Steel Institute, 1918, No. 2.
† Transactions of the American Society of Mechanical Engineers, 1895, Vol. 16.

Annual Meeting of the German Foundry Technical Association.

(*Continued from page 78.*)

the results of research work, because from this may arise the danger of laying independent claim to processes which have existed for a long time. Some means must be found for overcoming the chaos which thereby results. Research workers and firms ought not to keep quiet and wait to see the practical outcome of any particular development, and then claim as their own, not only every progress in the field of cast improvements, but similar work that has been done in the past.

Social Evening.

The members and visitors, with their ladies, attended a social in the evening in the "Kaiser" salon of the Rheingold Restaurant, Berlin, where Director Scharlibbe, the President of the Brandenburg Section of the Society, welcomed the visitors, and especially the foreign guests and the representatives of the city of Berlin.

Spindles for Loam Moulding.

By A. Sutcliffe.

Strange though it may seem, there exists in foundry literature a dearth of real practical information as to the construction and use of strickles as used for loam moulding.

The half-box spindle shown in Fig. 1 consists of a round rod with a square end on to which is fitted a handle for rotation. The sketch shows the full spindle and handle, and is sufficiently clear to illustrate the end of the box with the two halves of the box assembled to-

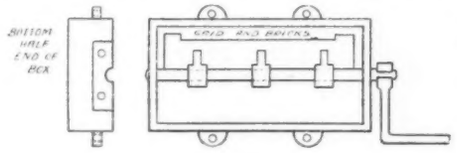


Fig. 1.

gether. The strickle here is used to make the sweep of the casting, and a straight edge is then worked on the edges of the box parts to form a level joint. This is done in both halves of the box; afterwards the top box, when dry, is turned

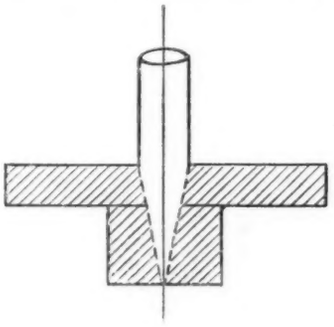


Fig. 2.

over. The top and bottom should then close together without any fin at the joints.

Fig. 2 shows the ordinary single dandy spindle, of a type more commonly used than any other, whilst Fig. 3 illustrates a double dandy. The author has cast flywheels and rope-pulleys weighing many tons and measuring as much as 20 ft. dia. and has used the double-dandy

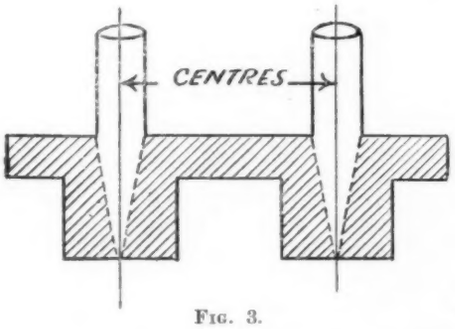


Fig. 3.

method, but invariably encountered one drawback. When two spindles are used, the slightest variation off the perpendicular in setting one of them throws the bed off the level. Whilst this would not matter very much with a single spindle owing to the complete job being on the same plane, it throws out of truth the arm-cores and causes them to fit very badly, when the bed, on one or two spindles, dips slightly towards the outside. The greater the diameter, of course, the worse the defect appears. For this reason the single spindle is considered superior.

Fig. 4 is a spindle which is made to fit the hole of a wheel-moulding-machine foundation; this spindle is just an eccentric, forming a single spindle fitting into slots and into the hole in the foundation. The slots stop the spindle from turning round as well as the reverse of the spindle, as one-half of the mould is strickled, and then the spindle is reversed into the other slot on the other side of the hole; the second half of the mould is then made ready for the dividing cores. This constitutes a handy method for the foundry, where such a foundation already exists.

Fig. 5 is an eccentric spindle and consists of an ordinary spindle with a crank throw at the

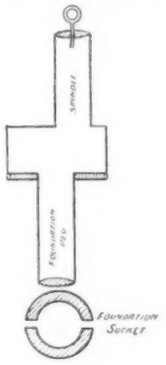


Fig. 4.

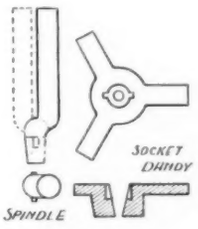


Fig. 5.

bottom, or socket-end. There are two slot keys on this end, one on each side which fits into slots cut in the socket (see Fig. 4). One side of the job is swept up and then the arm is lifted off the spindle, which is then reversed with the crank-throw to the opposite side. This, when the other half of the job is swept up, leaves the mould oval-shaped. There is also a serious fault with this system which is absent from the straight single spindle. This is when bosses or prints are bedded in on the spindle; they have to be drawn out to dig the sand from around

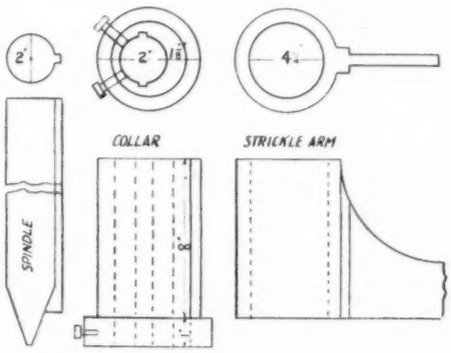


Fig. 6.

the socket and crank-end to leave clearance for the spindle leaving the socket and reversing. In order to avoid this fault some years ago the author has used very successfully a spindle that did not have to be reversed and which remained the true centre of the job from start to finish. This is shown in Fig. 6. The spindle has a slot-key all the way down into the socket, which has a slot cut to receive it as shown. Over this is placed the eccentric collar. This is tightened on to the spindle by means of grub-screws as shown. The sweeping arm fits over the collar and works loose on it. One side is struck up and the arm boards lifted off. The collar is then reversed and the arm put back to finish the other side of the job. The advantages of this method will be apparent to moulders who use the crank-throw system. The sketches shown in Fig. 6 refer to a 2-in. spindle with a throw of 1⅛ in., but the same principle can be extended to any size desired.

Fig. 7 is the wall-spindle, which consists of two wall-brackets and a straight piece about

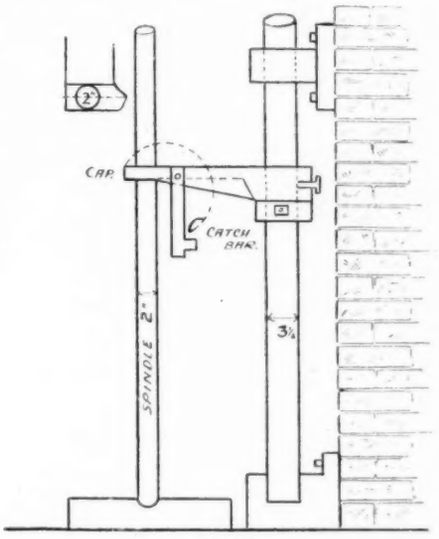


Fig. 7.

18 ft. long and 3½ ft. round iron arms, and collars on this shaft can be moved to any height, whilst another arm may be added if desired.

The author has in use a shaft with three arms, all at different heights. This wall tackle is adequate for any job and any spindle. Preference is given to a 2-in. spindle which is quite firm when the catch is over the cap, and the cap is on a hinge. The 2-in. spindle, as shown, fits into a small hole in the floor plate, this plate being a fixture and quite level.

The Technical Exhibit.

The exhibit prepared by the Cast Iron Research Association, as a section of the Technical Exhibit at the recent International Foundry Trades Exhibition, has, at the request of Sir Henry Lyons, F.R.S., Director of the Science Museum, South Kensington, been transferred there for exhibition for a period of some four or five months. The exhibit is now open for public inspection and is situated immediately on the right of the main entrance in the gallery containing the exact model of Stephenson's "Rocket" made for Mr. Henry Ford. The museum is open from 10 a.m. to 6 p.m. and on Sundays from 2.30 to 6 p.m.

Nottingham University Visited.

Foundrymen and engineers belonging to the Nottingham, Derby, Leicester, Lincoln, Grantham and Newark Societies, which form the East Midland area, paid a visit to the new Nottingham University buildings on Saturday last.

Following tea, a prize of £10, with certificate, given by the Societies in the area for an essay on any engineering subject, was presented to Mr. Cecil Dinsdale for a Paper on "Impurities in Steel, from the View of the Steel User," with which he won the Nottingham Society's prize. Mr. Dinsdale is employed by Messrs. Ruston & Hornsby, of Grantham.

National Smelting Company, Limited.—Net profit, £184,212; brought in, £59,674; final dividend on ordinary shares, 10 per cent.; and 2 per cent., making 10 per cent., on preference shares; carried forward, £73,886.

Trade Talk.

Messrs. Oxley & Company (Machinery), Limited, have removed from White Buildings, Fitzalan Square, Sheffield, to Central Works, Savile Street, Sheffield.

Messrs. Swan, Hunter & Wigham Richardson, Limited, have recently booked a contract for two vessels of moderate size for the Compagnie de Navigation, of Marseilles.

We understand that the London Power Company, Limited, have notified Messrs. Ferranti, Limited, that their tender for three 80,000-k.v.a. 11/66-k.v. 3-phase transformers has been accepted.

Messrs. Hall, Russell & Company, Limited, Aberdeen, have secured a contract for a motor yacht. The order has been placed by Messrs. G. L. Watson & Company, naval architects, Glasgow, and the vessel is to the order of an Edinburgh party.

An order for a large twin-screw motor vessel for the Holt Line has been placed with Messrs. Scotts' Shipbuilding and Engineering Company, Limited, Greenock. Messrs. Scotts are at present constructing three other motor vessels of similar dimensions for the same owners.

Palmer's Shipbuilding Company launched at Jarrow recently the motor tanker "Lucalus," of over 9,000 tons, for the Lucigen Steamship Company, Limited, of Liverpool. The tanker is fitted with Sulzer Diesel engines supplied by the Wallsend Slipway and Engineering Company, Limited.

Messrs. Workman, Clark, Limited, have launched the cargo steamer "Forthbank," the third of eight vessels which they have on order for Messrs. Andrew Weir & Company for the services of the Bank Line. The propelling machinery consists of directing acting inverted quadruple-expansion engines.

Messrs. Dorman, Long & Company, Limited, of Middlesbrough, have secured the contract for the building of the new Bangkok memorial bridge, celebrating the 150th anniversary of the foundation of the city. It is understood that between 2,500 and 3,000 tons of Tees-side produced steel will be used on the work.

A contract for structural steelwork, valued at approximately £250,000, has been secured by Messrs. Redpath, Brown & Company, Limited, Edinburgh, for the buildings at the new Ford motor works at Dagenham, Essex. The buildings cover 25 acres, and the steelwork will be made in London, Manchester, Edinburgh and Glasgow.

The Semet-Solvay and Piette Coke Oven Company, Limited, of Howard Chambers, 155, Norfolk Street, Sheffield, have changed the name of the company to Chemicals & Coke Ovens, Limited, with the registered office as before. The telegraphic address has also been altered to "Chemunion." A London office has been opened at Vintry House, Queen Street Place, E.C.4.

The secretaries of the Board of Conciliation for the Regulation of Wages in the pig-iron trade of Scotland have been informed by the auditors that they have examined the employers' books for April, May and June, 1929, and certified that the average net selling price is £3 13s. 3d. This means that there will be an increase in the wages of the workmen of 1 per cent. on basis rates.

Messrs. Cammell Laird & Company, Limited, are to build three new vessels for the Canadian National Railway Company's Pacific Coast service at their shipbuilding yards at Birkenhead. These ships, which are expected to be put into commission early next summer, will be 384 ft. long and 57 ft. in beam, and will operate both a passenger and cargo service on the Pacific coast of Canada.

Messrs. John Henderson & Company, Limited, engineers, Aberdeen, have received an order from the engineering firm of Messrs. Sir John Jackson (Singapore), Limited, the main contractors for the Singapore naval base, for the construction of eight electrically-driven travelling aerial cableways in connection with the construction of docks, dock walls and wharves at the naval base. The cableways are to handle loads of five tons, and will have spans varying from 350 ft. to 860 ft.

To meet the demands for larger work than they were equipped for carrying out, a considerable extension was recently put in hand by Fescol, Limited, of 101, Grosvenor Road, Westminster, London, S.W.1. This has now been completed, and enables them to "Fescol"-ise articles measuring 10 ft. by 6 ft. 9 in. by 13 ft. 6 in. external dimensions, whilst rams, shafts, etc., up to 20 ft. long can be handled. In connection with this plant, a runway has been installed capable of transporting articles up to 6 tons in weight.

A mean speed of 16 knots was achieved by the new twin-screw motor cargo and passenger vessel, "Cingalese Prince," at its official trials on the Clyde. The vessel, which was built by the Blythswood Shipbuilding Company, Limited, Scotstoun, for the Rio Cape Line, Limited, is intended for trading between New York and Far-Eastern ports. The main machinery, which consists of two sets of engines of the Doxford opposed piston type, each having four cylinders, has been supplied by Messrs. Richardsons, Westgarth & Company, Limited, West Hartlepool.

Obituary.

The death took place suddenly whilst on holiday of Mr. John Richard Appleby, managing director of Messrs. John Broadfoot & Sons, Limited, engineers and brassfounders, Scotstoun, Glasgow, on July 21.

The death occurred on July 19 of Mr. Archibald M'Farlane, who was 85 years of age and one of the founders, 60 years ago, of the firm of J. & A. M'Farlane, Limited, Albert Works, Glasgow, makers of washing and household machines.

Mr. Barzilla Riley, founder and last surviving partner of the original firm of Riley Bros., boilermakers, of Stockton, died on Thursday, July 18, at Stockton. Mr. Riley, who was in his 90th year, was a native of Stanningley, near Leeds, and after a short period in business on his own account established the Perseverance Boiler Works in 1860 with his brother. He was the oldest Freemason on Tees-side.

Mr. John Bell, who died on July 23, at Grangemouth, at the age of 72, had a very interesting family connection which was not very widely known. He was a great-grand-nephew of Henry Bell, the famous mechanic and introducer of steam navigation into Europe, whose tiny vessel, "The Comet," with engine constructed by himself, was successfully launched on the Clyde in 1812, the first in European waters. Henry Bell died at Helensburgh in 1830. Like his famous ancestor, John Bell was born at Torphichen, his birthplace being Carribber Mill. For many years he has been well known at Grangemouth Docks.

Company Meetings.

An amended scheme of reorganisation of the capital of William Beardmore & Company, Limited, was submitted to meetings of the debenture, note and shareholders on July 29. A further meeting is to be held on August 9. The "A" income debenture stock is to be non-cumulative, so long as any of the first debenture stock is outstanding. The banks and Government will receive "A" income debenture stock and 6 per cent. non-cumulative first preference shares, and the noteholders and the Government (for balance of its debt) 6 per cent. non-cumulative second preference shares. This means a rearrangement of the share and loan capital, and changes in regard to the future management of the company are also proposed. As regards management, the board will now consist of not more than seven directors, all to be nominated, so long as any of the first mortgage debenture or "A" income stock is outstanding, by a committee with the approval of the Governor of the Bank of England. The ten ordinary shares carrying the voting control, which under the original scheme were to be vested in the trustees for the "A" income debenture stock, are to be vested in a committee of three persons. This committee will have power to authorise the directors to require the trustees to concur in any sale of the assets which it may be deemed advisable to realise. The provision for the preference and ordinary shareholders will be the same as in the original scheme.

Sir John M. Macleod, C.A., Glasgow, has intimated to Messrs. James C. Bishop and Owen Coyle, joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board, that the average net selling price is £10 12s. 2d. This means that there will be no change in the wages of the workmen.

Personal.

Mr. Carson, who has managed the boiler department of Messrs. Barclay, Curle & Company, Limited, Glasgow, has just celebrated his diamond wedding.

Dr. Eric W. Fell, of Ulverston, and formerly of Beckermet, has been appointed to the Steel Industries of Great Britain, Limited (Austin Friars Trust), formerly the United Steel and other companies, at Sheffield, where he will be engaged in metallurgical research.

Mr. James Marshall, who has been in the employ of Messrs. Smith & Wellstood, Limited's, foundry at Bonnybridge, for 53 years, has just celebrated his golden wedding. Mr. Marshall and his wife are both 73 years of age, and have resided in the same building throughout the whole of their married life.

Mr. Alexander MacCallum, of Falkirk, celebrated the fiftieth anniversary of his marriage on July 15. Mr. MacCallum is a native of Falkirk, and still carries on as a moulder in the foundry of the Grahamston Iron Company, where he has been employed for the past sixty years. Mr. MacCallum had thirteen children, eight of whom were boys, and these all saw active service in the war, one being killed whilst serving with the Gordon Highlanders.

Mr. R. Greenwood, general manager and director of Combustion Engineering, Limited, Derby, as briefly noted in a recent issue, has resigned his position to take up the appointment as managing director of Messrs. Craven Bros. (Manchester), Limited. Messrs. Craven Bros. is now part of the Sir W. G. Armstrong, Whitworth Company, Limited, and comprises Sir W. G. Armstrong, Whitworth Machine Tool Section, Thomas Shanks & Company, of Johnstone, and Messrs. Joshua Buckton & Company, of Leeds, together with the extensive "Craven" range of machine tools and cranes.

Wills.

Burch, A., of The Crest, Peaks Hill, Purley, Surrey, metal merchant ... £44,212

Booth, W., of Glasgow, at one time secretary of A. & J. Inglis, Limited, shipbuilders £115,430

Barker, John Arthur, of Bradford, a partner in Knowles & Company, ironfounders and machine makers ... £9,882

Boucher, H., of Calthorpe Road, Edgbaston, and Jubilee Brassworks, Bishopsgate Street, Birmingham, brassfounder £27,966

Habershon, M. J., of Ferham Villa, Rotherham, formerly a director of J. J. Habershon & Sons, Limited, steel manufacturers £13,614

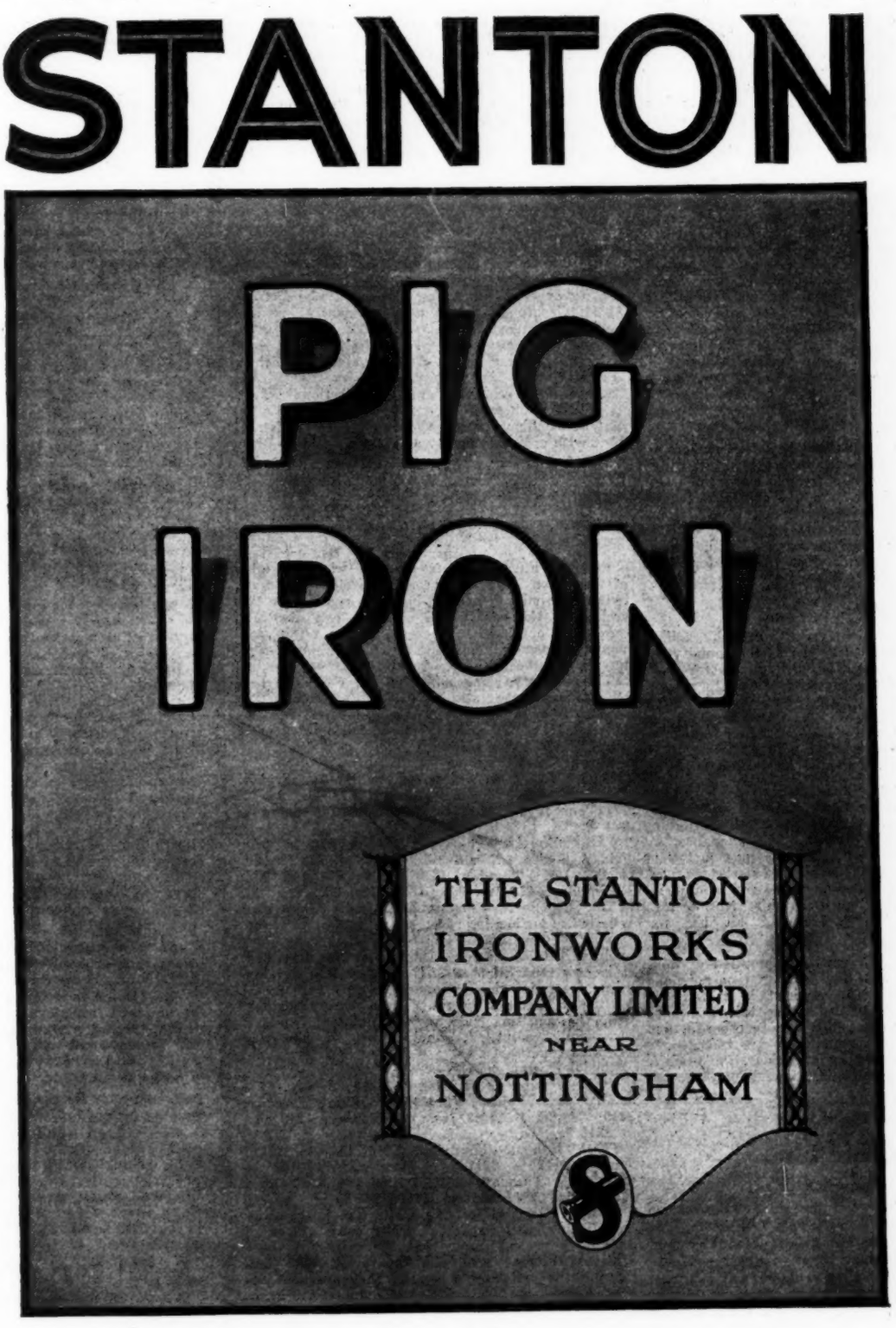
Cowan, Sir John, D.L., LL.D., of Salisbury Road, Edinburgh, engineer and iron and steel merchant, chairman and managing director of Messrs. Redpath, Brown & Company, Limited, of Manchester, London, Glasgow and Edinburgh £35,426

Falkirk Foundry Fusion.

It is announced that the Grangemouth Iron Company, Limited, Falkirk, have acquired from July 29 the plant, patterns, goodwill and assets, excepting buildings, of Messrs. Watson, Gow & Company, Limited, Etna Ironworks, Falkirk. The staff of Messrs. Watson, Gow & Company, Limited, will be transferred to the Grange Ironworks, Camelon.

The Grangemouth Iron Company, Limited, is one of Sir Frederick L. MacLeod's interest, whilst Watson, Gow & Company, Limited, is the firm of which Mr. Matt Riddell, a past-president of the Institute of British Foundrymen, was managing director.

Third Empire Mining and Metallurgical Congress, South Africa.—Congress Headquarters (100, Fox Street, Johannesburg) have now published the "Preliminary Programme, March 24—May 9, 1930," with full information as to steamship services, itineraries of the different tours, and miscellaneous other information useful to all who intend to attend the Congress, including accommodation, expenditure, etc.


STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The position of the Cleveland iron trade, though practically without change since last reported, is by no means devoid of interest, the usual slowing-down of activity at this period of the year having been counteracted to some extent by a substantial inflow of orders recently placed for autumn deliveries. Not much more business may, however, be anticipated until after the holidays, but it is expected that some big autumn contracts will be given out, and in the meantime ironmasters have all the orders they can cope with. Some of the Cleveland makers expect to have a little iron for disposal about the end of September, but nothing earlier than that date, and buyers who are seeking prompt lots can only obtain them at special prices from merchants. In the export section it is not surprising to note a heavy decrease of shipments for the month just closed, unavoidable in the face of high price levels and scarcity of supplies, while it is also worthy of note that considerable quantities of Midland iron are being received in the district. Meantime, current quotations for Cleveland iron are unchanged, the makers' minima for deliveries over the fourth quarter of the year being as follow:—No. 1 foundry iron, 75s. per ton; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; No. 4 forge, 71s. per ton.

In the market for East Coast hematite, makers are still cutting prices in order to get business which, on present costs, leaves no possible margin of profit. Luckily some of them have old contracts for ore and coke at prices far below those now ruling, and they are giving the consumers the benefit of these contracts. Consequently quotations again rule at 75s. for mixed numbers, and at 75s. 6d. for No. 1 quality. On the North-West Coast prices remain firm, with Bessemer mixed numbers being quoted at 75s. per ton at works.

LANCASHIRE.—In this area, with the holiday season in full swing, conditions in the foundry pig markets may be regarded as fairly satisfactory, and there is nothing in the present position to support the view that less firm prices are likely to obtain for the present, at all events. Current quotations, therefore, still rule as follow:—Staffordshire No. 3, 73s.; Derbyshire No. 3, 72s., with Scottish brands 91s. to 92s. per ton, delivered local stations.

THE MIDLANDS.—Little movement can be reported in this week's local markets for foundry pig, buying on consumer's account usually dwindling to a minimum at this season. The announcement by makers last week to increase the zone quotations had hardly been anticipated in market circles, current quotations consequently now ruling:—Staffordshire No. 3, 77s.; Derbyshire No. 3, 76s., and North Hants No. 3, 72s. 6d., all per ton delivered local stations.

SCOTLAND.—Only a partial resumption of work in local foundries has been so far reported, and consequently business in pig-iron is still on a restricted scale. Notwithstanding this drawback the market seems to be a little more cheerful, and in one or two sections conditions are reported to be better. With regard to quotations, the price is unaltered at 76s. per ton minimum for No. 3 Scotch foundry, f.o.t. furnaces.

Finished Iron.

At Birmingham this week the prices of the various grades of Staffordshire iron bars are without change; the best grades of crown iron being quoted at between £10 and £10 5s., although other crowns are offered by certain Staffordshire mills at figures varying from £9 15s. to £10 and from works outside this area £9 10s. and £9 12s. 6d. per ton is being quoted. The improvement which has been manifest recently is maintained, and there is also a distinct improvement in the demand for Staffordshire marked bars, which are offered at £12 per ton at works. There is no alteration in the situation governing nut and bolt iron, which remains without improvement, prices still favouring imported material.

Steel.

At Sheffield the steel market is active for basic billets, but no improvement is shown in Siemens acid billets, which have been in poor demand for many months, and there is no indication of any early revival. The only price movement in local materials is that ferro-tungsten and tungsten powder have moved up 2d. per lb. to 2s. 11d. and 3s. 2d. per lb. respectively. The market for finished steel materials continues irregular. Overseas buyers are inclined to watch the position, as Continental quotations continue to show a weak tendency. The tinplate market remains quiet, with prices practically unchanged from previous quotations.

Scrap.

Business in all descriptions of foundry scrap material continues quiet as a rule, with little more activity expected until after the end of the quarter. At Middlesbrough the value of ordinary heavy cast iron is unchanged at 66s., whilst 68s. 6d. is quoted for good machinery quality. In the Midlands there is a good demand for cast-iron material, which is firm at 70s. to 72s. 6d. for machinery quality, and 60s. for light cast-iron scrap. In Scotland only a moderate business in this class of material is reported, machinery cast-iron scrap being on offer at 70s., with ordinary quality at 63s. 6d. Old cast-iron chairs are quoted at 66s. per ton, and light cast iron at 60s. per ton. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Fluctuations in values of warrant copper of late have invariably been on a minimum scale, indicating only a limited business passing in this section of the base metal markets, and due in a measure, doubtless, to seasonal falling off in consumptive demand. With regard to the future, buying has been cut down to the lowest possible minimum for so long now that it is obvious that stocks must be steadily dwindling, and that eventually a stage must be reached when considerably more interest will have to be taken in covering immediate requirements.

Closing quotations are :—

Cash.—Thursday, £72 2s. 6d. to £72 5s.; Friday, £72 5s. to £72 7s. 6d.; Monday, £72 18s. 9d. to £73; Tuesday, £73 5s. to £73 6s. 3d.; Wednesday £73 3s. 9d. to £73 5s.

Three Months.—Thursday, £73 to £73 2s. 6d.; Friday, £73 2s. 6d. to £73 5s.; Monday, £73 13s. 9d. to £73 15s.; Tuesday, £73 15s. to £73 16s. 3d.; Wednesday, £73 12s. 6d. to £73 13s. 9d.

Tin.—The market for standard cash tin last week reflected a further improvement in values, thus confirming previous impressions of the stimulating effect upon markets of the new organisation then described. It is now reported that further interesting developments are proceeding in connection with the scheme for the stabilisation of tin. These movements deal with the smelting side of the industry, and, if successfully completed, should prove of very considerable importance.

Official closing prices :—

Cash.—Thursday, £212 15s. to £213; Friday, £213 to £213 5s.; Monday, £214 15s. to £215; Tuesday, £213 12s. 6d. to £213 15s.; Wednesday, £213 10s. to £213 12s. 6d.

Three Months.—Thursday, £216 15s. to £217; Friday, £217 to £217 5s.; Monday, £218 10s. to £218 15s.; Tuesday, £217 7s. 6d. to £217 10s.; Wednesday, £217 10s. to £217 12s. 6d.

Spelter.—Demand for this metal has fallen away considerably, and buyers generally show a lack of interest, with the result that the market is very depressed. Prices are at a low level, but, considering the period of the year, they are not considered unreasonably low, and will appreciate again when the end of the summer slackness brings with it an improved demand.

Daily quotations are :—

Ordinary. — Thursday, £25 2s. 6d.; Friday, £25 2s. 6d.; Monday, £25 5s.; Tuesday, £25 3s. 9d.; Wednesday, £25 2s. 6d.

Lead.—As is only to be expected at this period, the demand from all European countries is slack, with the result that the present level of values is on the low side. Supplies are adequate for all requirements, and the position is devoid of interest as the result of the seasonal slackness generally experienced.

Prices have been :—

Soft Foreign Prompt.—Thursday, £22 10s.; Friday, £22 13s. 9d.; Monday, £23; Tuesday, £23 1s. 3d.; Wednesday, £22 15s.

Students' Corner

Q.—What are the usual dimensions and capacity of kilns?

A.—The shell of the kiln, which is of wrought iron or steel plates, is 33 ft. by 24 ft. dia. and lined with firebricks. It will calcine about 1,000 tons of ironstone per week.

Q.—Why is lime necessary in the blast-furnace charge?

A.—The function of lime in a blast-furnace is to form a fusible free-flowing slag. This is necessary when one considers that the ash from 20 cwts. of coke per ton of iron made must be regularly fluxed. In addition to the coke ash, the silica, alumina and other foreign matter in the ironstone must be eliminated whilst the furnace is working and in blast.

Q.—What percentage of ash would the coke give, and what amount of slag per ton of iron made would have to be dealt with?

A.—About 10 per cent. of ash from the coke would need fluxing, the amount of slag made per ton of iron produced is about 30 cwts.

Q.—How does the lime function?

A.—Broadly speaking, an acid is the oxide of a non-metal and a base is the oxide of a metal, both of which have a strong chemical affinity for each other. The ash from the coke and silica are chiefly acids, lime is basic, the metal calcium being its base. Acids and bases react and combine in definite proportions, but the balancing and determination of these in blast-furnace practice is far too large a subject to be dealt with here. To put this action into a simple form—when the acids and bases are in the region of a temperature of about 1,200 deg. C. they combine with each other and form a fusible free-flowing slag. The slag or cinder from the blast-furnace may be regarded as silicates. Some ores contain sufficient lime to flux themselves.

Q.—What happens if the ore does not contain enough lime to flux itself, and no lime is added to the furnace charge?

A.—Under those conditions the acids, at certain temperatures and proportions, having a strong chemical affinity for bases, will combine with ferrous oxide, and the resulting slag will contain a large percentage of iron.

Q.—What is the common fuel now used for smelting in the blast-furnace?

A.—A good quality coke. There are still a few of the old furnaces using coal, or part coal and part coke. These are generally the open-top type of furnace which are fast disappearing. Coke from a retort process of making is chiefly used at present by reason of the yield of by-products.

Q.—What are the by-products from coke making?

A.—Sulphate of ammonia tar, and gas, etc.

Q.—What is the advantage of using hot blast compared with using cold blast?

A.—When using hot blast the saving effected in fuel alone is said to be 14 cwts. of coke per ton of iron produced.

TRADE MARK.

"SERVICE BCM/GX FIRST"

"SANDS MAY COME
and
SANDS MAY GO"
but
"YORKSHIRE SAND"
GOES ON FOR EVER!

"YORKSHIRE SAND" THE STEELMOULDER'S FRIEND IS BETTER THAN EVER.

New and Scientific Mixing Processes have recently been perfected and installed, and our works equipped with Milling plant of the most efficient type, specially made for the work of sand preparation.

UNLIKE BELGIAN SANDS

—one thing to-day and another to-morrow—"Yorkshire Sand" does not vary in either grain size or percentage of bond and it is absolutely free from stones and lumps of clay,

AND

IT IS CHEAPER IN USE THAN ANY FOREIGN SAND.

The whole country is suffering from unemployment due principally to the unrestricted importation of unnecessary foreign goods—why not nail your colours to the mast and adopt the slogan—

"BUY BRITISH STEEL CASTINGS AND BRITISH SANDS!"

If the proposition presents any difficulty, send for us to talk it over and we will undertake to meet your reasonable views. If you use foreign sand, you can't legitimately complain of engineers using foreign castings.

We don't sell foreign castings and deprive you of work. We support British Institutions and trade and technical associations. We live here and pay British rates and taxes. We help to buy your output.

We don't ask for orders for 500-ton lots (payment against B/L), we sell in truck loads and wait for our money—sometimes three or four months (sometimes we never get it at all). We are always here at the end of a wire for advice, help or support. If you receive from us any goods you don't like—send them back.

We give prompt delivery of Yorkshire Sand and every ton lot of it you buy finds work for Englishmen and Scotsmen and helps to improve your own business by circulating more money in the country, and reducing the amount sent abroad for needless foreign purchases.—Think it over and you will see we are right.

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GENERAL REFRACTORIES, LTD.

SHEFFIELD.

Telephone: 22311.

Telegrams: "GENEFRAX, SHEFFIELD."

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	73	3	9
Three months	73	12	6
Electrolytic	84	5	0
Tough	76	5	0
Best selected	76	5	0
Sheets	110	0	0
India	95	0	0
Wire bars	84	12	6
Do. Aug.	84	12	6
Do. Sept.	84	12	6
Ingot bars	84	12	6
H.C. wire rods	86	17	6
Off. av. cash, June	74	7	9
Do. 3 mths., June	73	19	3⅜
Do., Sttlmnt., June	74	8	0
Do., Electro, June	84	7	0
Do., B.S., June	77	8	1½
Aver. spot price, copper, June	74	7	9
Do. wire bars, June	84	13	9

Solid drawn tubes .. .. .. 15d.
Brazed tubes .. .. .. 15d.
Wire .. .. 12½d.

BRASS.

Solid drawn tubes .. .. .. 12½d.
Brazed tubes .. .. .. 14½d.
Rods, drawn .. .. .. 12½d.
Rods, extd. or rlld. .. .. 8d.
Sheets to 10 w.g. .. .. .. 11⅛d.
Wire .. .. 11⅛d.
Rolled metal .. .. .. 10½d.
Yellow metal rods .. .. .. 8d.
Do. 4 × 4 Squares .. .. 8½d.
Do. 4 × 3 Sheets .. .. 9d.

TIN.

	£	s.	d.
Standard cash	213	10	0
Three months	217	10	0
English	214	0	0
Bars	216	0	0
Straits	217	2	6
Australian	215	17	6
Eastern	221	0	0
Banca	Nominal		
Off. av. cash, June	200	5	9½
Do., 3 mths., June	203	9	6
Do., Sttlmt., June	200	5	4½
Aver. spot, June	200	5	9½

SPELTER.

	£	s.	d.
Ordinary	25	2	6
Remelted	22	15	0
Hard	21	0	0
Electro 99.9	27	5	0
English	25	12	6
India	22	0	0
Zinc dust	(Nom.) 34	10	0
Zinc ashes	8	15	0
Off. aver., June	26	2	0
Aver., spot, June	26	4	3½

LEAD.

	£	s.	d.
Soft foreign ppt.	22	15	0
English	24	5	0
Off. average, June	23	12	11½
Average spot, June	23	13	10½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	34	10	0
Do. V.M. ex-whf.	32	12	6
Rods	40	0	0
Boiler plates	30	10	0
Battery plates	31	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	50	5	0
Chinese	31	15	0
Crude	Nominal		

QUICKSILVER.

Quicksilver 22 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
25% 7 15 0
45/50% 12 0 0
75% 19 10 0
Ferro-vanadium—
35/50% .. .. 12/10 lb. Va.
Ferro-molybdenum—
70/75% c. free .. 4/- lb. Mo.
Ferro-titanium—
23/25% carbonless .. 11d. lb.
Ferro-phosphorus, 20/25% .. £16 0 0
Ferro-tungsten—
80/85%, c. fr. .. .. 3/3½ lb.
Tungsten metal powder—
98/99% .. .. .. 3/6½ lb.
Ferro-chrome—
2/4% car. £32 10 0
4/6% car. £23 15 0
6/8% car. £23 0 0
8/10% car. £22 15 0
Ferro-chrome—
Max. 2% car. £33 15 0
Max. 1% car. £37 12 6
Max. 0·70% car. £41 12 6
70%, carbonless .. .. 1/2 lb.
Nickel—99% cubes, or pellets £175 0 0
Ferro-cobalt .. .. .. 9/4 lb.
Aluminium 98/99% £95 0 0
Metallic chromium—
96/98% .. .. .. 2/6 lb.
Ferro-manganese (net)—
76/80% loose £13 15 0
76/80% packed £14 15 0
76/80%, export £14 10 0
Metallic manganese—
94/96%, carbonless .. 1/6 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten £0 2 0
Finshed bars, 18% tungsten £0 2 9
Per lb. net, d/d buyers' works.
Extras—
Rounds and squares, 3 in. and over .. .. 4d. lb.
Rounds and squares, under ½ in. to ¼ in. .. .. 3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in... 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. .. .. 3d. lb.
Do., under ½ in. × ¼ in. .. 1/- lb.
Bevels of approved sizes and sections .. .. 6d. lb.
Bars cut to length, 10% extra

SCRAP.

South Wales—	£	s.	d.		£	s.	d.
Heavy steel	3	17	0	to	3	17	6
Bundled steel and shrngs. ..	3	12	6	to	3	15	0
Mixed iron and steel ..	3	13	6	to	3	16	6
Heavy cast iron ..					3	2	6
Good machinery for foundries ..					3	7	6
Cleveland—							
Heavy steel ..					3	5	0
Steel turnings ..					2	17	6
Cast iron borings ..					2	17	6
Heavy forge ..					3	17	6
W.I. piling scrap ..					3	12	6
Cast-iron scrap	3	6	0	to	3	8	6
Lancashire—							
Cast-iron scrap	3	0	0	to	3	10	0
Hvy. wrought ..					3	12	6
Steel turnings ..					2	17	6
Scotland—							
Heavy steel ..					3	16	0
Cast-iron borings ..					2	15	0
Wrought-iron piling ..					3	13	6
Heavy machinery ..					3	10	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean) ..	62	0	0
Brass	41	0	0
Lead (less usual draft) ..	20	0	0
Tea lead	16	10	0
Zinc	17	0	0
New aluminium cuttings ..	68	0	0
Brazierv copper	54	0	0
Gunmetal	54	0	0
Hollow pewter	150	0	0
Shaped black pewter ..	106	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—
Foundry No. 1 .. .. 75/-
Foundry No. 3 .. .. 72/6
Foundry No. 4 .. .. 71/6
Forge No. 4 .. .. 71/-
Hematite No. 1 .. .. 75/6
Hematite M/Nos. 75/-

N.W. Coast—
Hem. M/Nos. d/d Glas. .. 86/-
„ d/d Birm. 92/-

Midlands—
Staffs. common* .. .. —
„ No. 4 forge* .. 70/6
„ No. 3 fdry* 77/-
Shrops. basic .. .. —
„ Cold blast, ord. .. —
„ „ roll iron .. —
Northants forge* 66/-
„ fdry. No. 3* .. 72/6
Derbyshire forge* 69/6
„ fdry. No. 3* .. 76/-
„ basic* .. .. —
* d/d Black Country dist.

Scotland—
Foundry No. 1 .. .. 78/6
„ No. 3 .. .. 76/-
Hem. M/Nos. 80/-

Sheffield (d/d district)—
Derby forge 64/6
„ fdry. No. 3 .. 68/6
Lincs. forge .. .. —
„ fdry. No. 3 .. 72/6
E.C. hematite 86/-
W.C. hematite 87/6

Lincs. (at furnaces)—
Forge No. 4 .. .. —
Foundry No. 3 .. .. —
Basic .. .. .. —

Lancashire (d/d eq. Man.)—
Derby forge .. .. —
„ fdry. No. 3 .. 73/6
Northants foundry No. 3 .. —
Dalzell, No 3 (special) 102/6 to 105/-
Summerlee, No. 3 .. .. 93/6
Glengarnock, No. 3 .. —
Gartsherrie, No. 3 .. .. 93/6
Monkland, No. 3 .. .. 93/6
Shotts, No. 3 .. .. 93/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.) nom. ..					10	15	0
Nut and bolt iron	9	0	0	to	9	5	0
Hoops ..	11	0	0	to	11	10	0
Marked bars (Staffs.) f.o.t.					12	0	0
Gas strip ..	11	0	0	to	11	10	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	12	6	to	8	17	6
Boiler plts. ..					10	10	0
Chequer plts. ..					10	12	6
Angles					8	2	6
Tees					9	2	6
Joists					8	2	6
Rounds and squares, 3 in. to 5½ in.					9	2	6
Rounds under 3 in. to ¾ in. (Untested) ..					8	0	0
					and upwards		
Flats, over 5 in. wide and up					8	7	6
Flats, 5 in. to 1½ in. ..					7	17	6
Rails, heavy					8	10	0
Fishplates					12	10	0
Hoops (Staffs.)	10	0	0	to	10	10	0
Black sheets, 24g.	10	5	0	to	10	10	0
Galv.cor.shts., 24g.	13	5	0	to	13	12	6
Galv. fencing wire 8g. plain			12	0	0		
Billets, soft	6	7	6	to	6	17	6
Billets, hard	7	10	0	to	8	2	6
Sheet bars	6	5	0	to	6	10	0
Tin bars	6	5	0	to	6	10	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6½
Rods	1/5
Tubes	1/9½
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising ..	10d. to 1/4
Rolled—	
To 9 in. wide ..	1/4 to 1/10
To 12 in. wide ..	1/4½ to 1/10½
To 15 in. wide ..	1/4½ to 1/10½
To 18 in. wide ..	1/5 to 1/11
To 21 in. wide ..	1/5½ to 1/11½
To 25 in. wide ..	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bessemer billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.95
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.60
Sheets, blue an'l'd, No. 13 ..	2.35
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.30
Tinplates, 100 lb. box	$5.35

COKE (at ovens).

Welsh foundry	25/- to 27/6
„ furnace	21/- to 23/-
Durham and North.	
„ foundry ..	18/6 to 20/6
„ furnace	19/-
Midlands, foundry ..	—
„ furnace ..	19/- and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes ..	20×14 box	..	18/3
„ ..	28×20 „	..	36/6
„ ..	20×10 „	..	26/3
„ ..	18½×14 „	..	18/9
C.W. ..	20×14 „	..	15/3
„ ..	28×20 „	..	33/6
„ ..	20×10 „	..	21/3
„ ..	18½×14 „	..	16/-
Terneplates ..	28×20	..	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron ..	£8	0	0	to	£7	10	0
Bars, hammered, basis ..	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis ..	£15	15	0	to	£16	15	0
Blooms ..	£10	0	0	to	£12	0	0
Keg steel ..	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods, dead soft, steel	£10	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
July	25	72	2	6	inc.	2/6
„	26	72	5	0	„	2/6
„	29	72	18	9	„	13/9
„	30	73	5	0	„	6/3
„	31	73	3	9	dec.	1/3

Electrolytic Copper.

		£	s.	d.		
July	25	84	0	0	No change	
„	26	84	5	0	inc.	5/-
„	29	84	5	0	No change	
„	30	84	5	0	„	„
„	31	84	5	0	„	„

Standard Tin (cash).

		£	s.	d.		
July	25	212	15	0	dec.	40/-
„	26	213	0	0	inc.	5/-
„	29	214	15	0	„	35/-
„	30	213	12	6	dec.	22/6
„	31	213	10	0	„	2/6

Tin (English ingots).

		£	s.	d.		
July	25	213	0	0	dec.	50/-
„	26	213	5	0	inc.	5/-
„	29	215	5	0	„	40/-
„	30	214	0	0	dec.	25/-
„	31	214	0	0	No change	

Zinc Sheets (English).

		£	s.	d.		
July	25	34	10	0	No change	
„	26	34	10	0	„	„
„	29	34	10	0	„	„
„	30	34	10	0	„	„
„	31	34	10	0	„	„

Spelter (ordinary).

		£	s.	d.		
July	25	25	2	6	inc.	1/3
„	26	25	2	6	No change	
„	29	25	5	0	inc.	2/6
„	30	25	3	9	dec.	1/3
„	31	25	2	6	„	1/3

Lead (English).

		£	s.	d.		
July	25	24	0	0	No change	
„	26	24	0	0	„	„
„	29	24	5	0	inc.	5/-
„	30	24	5	0	No change	
„	31	24	5	0	„	„

Exports of Iron Castings in June and the six months 1929, compared with June and the six months 1928.

	June, 1928.	June, 1929.	Six months, 1928.	Six months, 1929.	June, 1928.	June, 1929.	Six months, 1928.	Six months, 1929.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
BUILDERS' CASTINGS—								
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers—								
To Argentine Republic	163	87	869	1,111	7,840	5,282	37,334	53,134
„ British South Africa	375	136	1,905	1,847	12,238	5,492	66,235	65,554
„ „ India	132	33	821	854	6,557	1,656	36,514	33,268
„ Australia	69	51	359	355	5,243	3,259	25,495	21,957
„ New Zealand	139	64	1,002	710	6,992	3,677	49,358	46,494
„ Other countries	831	671	4,642	4,957	41,384	31,573	216,568	224,662
Total	1,709	1,042	9,598	9,834	80,254	50,939	431,504	445,069
PIPES AND FITTINGS—CAST—								
To Argentine Republic	685	811	4,378	13,692	7,931	7,786	46,713	132,042
„ British South Africa	306	446	2,608	3,867	6,079	5,805	42,060	49,273
„ „ India	639	678	4,916	2,434	8,087	4,814	61,490	30,500
„ Straits Settlements and Malay States	1,210	231	7,643	11,441	9,921	2,307	68,315	83,934
„ Ceylon	110	140	654	1,177	1,126	1,710	7,828	11,983
„ Australia	983	62	5,913	2,634	10,473	1,444	64,000	27,342
„ Other countries	4,627	3,783	30,432	29,587	58,143	50,227	399,200	360,819
Total	8,560	6,151	56,544	64,832	101,760	74,093	689,606	695,893
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	361	375	2,319	2,332	14,705	12,861	87,082	83,978
„ Enamelled	60	77	400	423	5,684	6,166	35,635	37,202
CASTINGS, in the rough—								
Iron	282	104	749	672	5,521	3,845	24,335	24,256
Steel	97	89	324	533	4,962	3,442	15,852	22,401

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SITUATIONS VACANT AND WANTED.

ASSISTANT MANAGER (30), Irish Free State foundry, seeks position as Representative for progressive firm doing business in Ireland; ten years' sound commercial and practical experience, all departments; efficient salesman, capable of introducing business; highest references.—Box 282, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

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FOREMAN wanted for South Staffs district; small repetition castings, grey iron, engineering and electrical stump and machine production; state age, wage and experience.—Address, Box 284, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—FOREMAN for steel foundry in North of England having output of 50 to 60 tons castings weekly; must have thorough knowledge modern steel foundry methods and held similar position in first-class works; preference given to man with experience of open-hearth, converter, and electric furnaces; state age, qualifications, fully, and salary required.—Box 288, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

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Generous commission paid.

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